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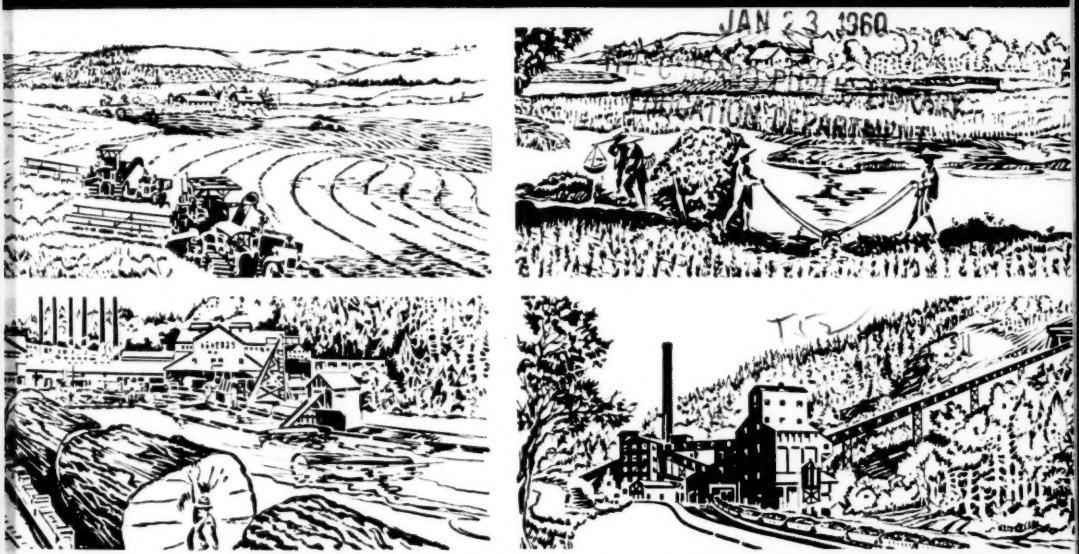

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THE RECLAMATION OF STRIP MINED LANDS IN WESTERN KENTUCKY

LEE GUERNSEY
Indiana State Teachers College

Introduction

LARGE reserves of shallow coal seams in Western Kentucky have encouraged strip mining. The coal seams usually lie below a maturely dissected plateau with rolling hills. Five nearly horizontal seams of coal lie within 90 feet of the surface and range from 2 to 12 feet in thickness. These physical conditions have facilitated strip mining methods within seven counties (Butler, Daviess, Hancock, Hopkins, Muhlenberg, Ohio, and Webster) of Western Kentucky (Fig. 1). Most of the strip mined coal is currently mined from No. 9 and No. 11 coal seams. They are typically covered with from 40 to 80 feet of overburden, have thicknesses of from 52 to 80 inches and are generally free from impurities. The strata overlying the coal seams are limestones, sandstones, and shales.[1]

Strip coal mining in Western Kentucky has left about 15,000 acres in spoil banks. Prior to 1954, there were no legal requirements to reclaim any of the strip mined lands in Kentucky. Since 1954, when the Strip Mining and Reclamation Act was passed, about 6,000 acres of spoil banks in Western Kentucky have been graded and revegetated by strip coal mining companies.[2]

The Kentucky Strip Mining and Reclamation Act requires the coal operator to: (1) cover the face of the coal, (2) remove or bury all mine refuse, (3) grade spoil banks, and (4) provide a vegetative cover.[3] This required reclamation usually costs the strip mine operator about 50 dollars per acre which is normally less than one cent for each ton of coal mined.[4]

Five states legally require strip coal mining companies to reclaim all spoil banks. The first state to pass strip coal mine legislation requiring reclamation was West Virginia in 1939. This was followed by Indiana in 1941, Pennsylvania in 1945, Ohio in 1947, and Kentucky in 1954. The specific reclamation requirements vary considerably within these five states. The reclamation laws are variously administered by Divisions of Forestry, Bureau of Mines, Departments of Agriculture, and Departments of Conservation. Illinois (1943) and Maryland (1947) also passed strip coal mine reclamation laws but their constitutionality was tested and the Supreme Courts of both Illinois and Maryland have de-

[1] A. C. McFarland, *Geology of Kentucky*. University of Kentucky Press, Lexington, Kentucky, 1943, p. 111.

[2] Based on unpublished data from Strip Mining and Reclamation Commission, Department of Conservation, Frankfort, Kentucky.

[3] Section IX of Strip Mining and Reclamation Act. Commonwealth of Kentucky, 1954.

[4] Western Kentucky bituminous coal has a density of about 75 pounds per cubic foot. By using this value, an acre-foot of coal equals about 1,600 tons of coal. Thus, a four-foot seam would yield 6,400 tons of coal per acre. A reclamation cost of 64 dollars per acre would cost one cent per ton. Since most coal seams are thicker than four feet, and most reclamation costs are less than $64.00, reclamation normally costs less than one cent for each ton of coal mined in Western Kentucky.

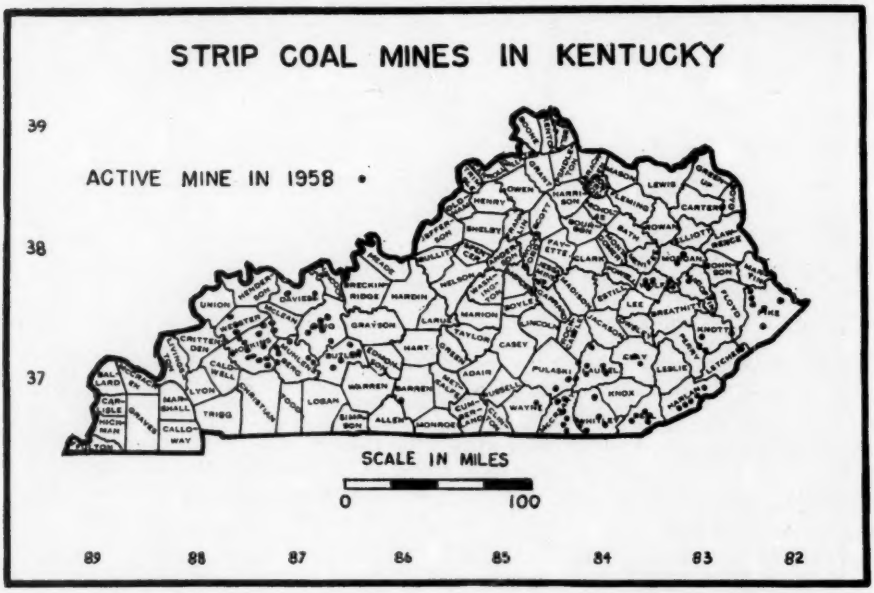

FIG. 1. Strip coal mines in Western Kentucky. (Data from files of Kentucky Strip Mining and Reclamation Commission.)

clared the strip mine reclamation laws unconstitutional. The courts found no legal justification for discrimination between coal and other surface mining companies.

Newly overturned earth of spoil banks create a desolate appearance of the landscape. New spoil banks, if left without proper kinds of reclamation, stand as an unsightly blot on the landscape. Natural vegetation will come up in some areas, but most areas will remain barren for some time. Natural revegetation produces an inadequate ground cover for several years.[5] Not only is this process very slow, but the trees or grasses which grow on spoil banks are practically all composed of less valuable species. In cases where a heavy volunteer stand of timber does develop on strip mined lands, the trees are generally short-boled, limby, and contain few high-grade products.

In addition to the slow growth, undesirable quality and poor species, natural tree stands have a further handicap of being poorly distributed over the spoil banks. The most valuable tree species are normally confined to the outer portions of the stripped areas. Saw-timber and pole trees generally occur only in scattered clumps. Most of the openings between trees are covered with undesirable or noxious weeds, grasses, briars and shrubs. The better timber species find it difficult to invade this type of ground cover. To reclaim spoil banks properly, the undesirable vegetation must first be removed.

Grading of Spoil Banks

The degree to which spoil banks should be graded is controversial. Most areas in Western Kentucky are only topped to a width of 12 to 15 feet on

[5] The writer has observed barren spoil banks which had been strip mined as many as 32 years ago.

FIG. 2. Grading to a width of 12 to 15 feet on strike-off ridges in Kentucky.

strike-off ridges (Fig. 2). A casual consideration of grading may lead observers to quickly conclude that complete levelling would reclaim the land and fit it for profitable future land use. On the other hand, strip mining companies are quick to point out a high cost of levelling spoil banks (Fig. 3). They also add that the topsoil is still buried which results in low productivity and reduced land values. Many strip mine operators oppose any grading of spoil banks. They usually state that grading causes excessive compaction which in turn causes poor aeration and slow permeability rates. These adverse physical conditions are usually

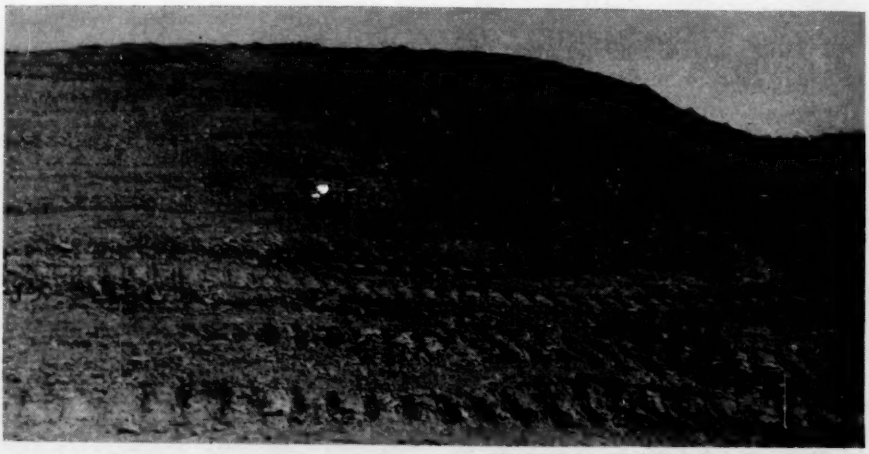

FIG. 3. Levelling of spoil banks near Beaver Dam, Kentucky. The levelling costs in 1956 were 22 dollars per acre.

said to be due to the weight of grading machinery and from the weight of the materials which were located above the newly formed surface before grading.

An analysis of the compaction of spoil material by the writer indicates the contrary (Table 1). Compaction tests show that graded spoil banks have a lower density than surrounding unmined lands.[6] The average of all graded spoil banks tested was 86.4 per cent as dense as natural soil density called Proctor Density. This is true despite the fact that all the field density tests were taken on spoils which had been unusually compacted by numerous trips of the tractor-crawler tracks. Thus, it appears to the writer that graded spoil banks are loose and friable enough to support any vegetation that can grow on adjacent unmined land.

TABLE 1

County	Field Density	Proctor Density	Percentage of Proctor
Ohio	111.0	120.0	92.5
Ohio	101.8	122.0	83.4
Daviess	102.9	110.6	93.0
Hopkins	76.3	111.2	68.6
Hopkins	112.8	121.4	92.9
Hopkins	90.2	104.6	86.2
Muhlenburg	96.3	110.7	87.0
Average	98.8	114.4	86.4

Variations in compaction ranged from 68.6 per cent to 92.5 per cent of the Proctor Density of unmined land. The field density compaction apparently depended mainly upon: (1) the length of time between the strip mining and grading processes, (2) the method of performing the grading process, (3) the time of year the grading was done, and (4) the moisture content at the time of grading. The least compact area had a short interval between strip mining and grading, had the dragline scatter the material, and graded the area with a crawler-tractor in the late summer when the spoil was dry.

Undoubtedly, grading is generally desirable. It makes strip-minded lands more accessible; a better seedbed can be prepared; less seed is required per acre; and it simplifies and lowers the cost of caring for crops. Grading also improves the appearance of the landscape during early years after strip mining and during winters when foliage is absent. It makes spoil banks available for pastures, weeds can be controlled more easily, grasses and legumes can be harvested as hay, and tree plantings and logging operations can be carried out more efficiently.

Tree Plantings

Tree planting has been the most popular method of revegetating spoil banks in Western Kentucky. Original tree planting costs are usually less than 20 dollars per acre. The planted trees grow rapidly, hide the spoil bank quickly, and provide an attractive ground cover. In a few years, tree plantings will probably provide scenic settings for recreational areas. Finally, these forested spoil banks may produce profitable forest crops in future years.

There are several physical factors which affect the success of tree plantings, but the two which are of overriding importance in affecting tree growth and survival are acidity and texture. Both acidity and texture of the spoil banks are determined primarily by the composition and structure of the stratum which lies immediately above the coal seam being strip mined. Some strata contain significant amounts of pyrite or other sulfur-bearing minerals. These minerals oxidize upon exposure to air. They produce sulfuric acid, low pH reactions, and

[6] The field density tests (Table I) were made possible through the courtesy of the Kentucky Department of Highways. A density machine was used to determine the volume and density of spoil material which was analyzed in the laboratory of the Kentucky Division of Materials.

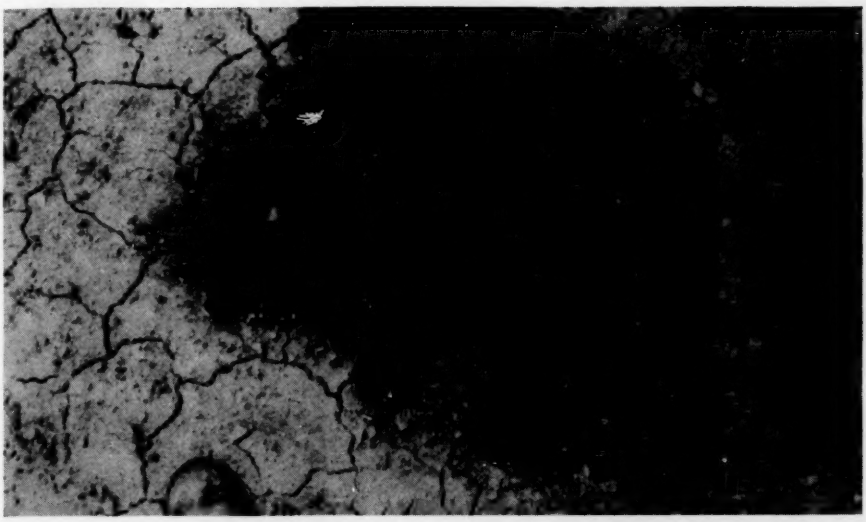

FIG. 4. Acid spot (dark area) on spoil bank.

often visible acid spots (Fig. 4). The acid areas need to be recognized and avoided in tree plantings since very low tree survival rates occur in highly acidic areas. The texture of spoil banks varies considerably. Most spoil banks are composed of a high percentage of rocks, and soil-sized particles normally make up less than one-third of the spoil bank material.[7] Strip mining turns the soil horizon upside down and the material placed on top consists mainly of rock which originally capped the coal seam.

Several different tree species have been planted on Western Kentucky's spoil banks, but not all species are equally well suited for this area, or of equal value. All species have a selective adaptation to areas having certain physical characteristics. But, in general, three main types of forests have been planted: (1) pines; (2) mixed pines and hardwoods; and (3) black locusts.

Pine plantations are composed of several different pine species each of which has peculiarities of site conditions and growth. The pine forests generally have a good survival rate but a slow growth rate. One problem of planting pine forests in Western Kentucky is that hardwoods tend to supersede pines. Pine plantings will probably be converted by natural succession to a hardwood forest. Pure pine forests, therefore, may be succeeded by low-quality hardwoods invading as volunteer species. Therefore, mixtures of desirable native hardwoods such as tupil poplar, white ash, red oak, sweet gum, white oak, and black walnut are recommended in the annual tree plantings.

Most forests planted on spoil banks since 1954 are mixtures of pines and hardwoods. These differ markedly in species composition depending upon the area planted. In the mixed pine-hardwood plantations, the stands are frequently characterized by what appears to be extensive openings. This is due to differential growth rates. The slower growing pine species are sometimes simply hidden by the faster growing hard-

[7] Doerr and Guernsey. "Man as a Geomorphological Agent: The Example of Coal Mining," *Annals of the Association of American Geographers*, Vol. 46 (1956).

FIG. 5. Five-year old pines (foreground) and black locusts (background) which were both planted in 1954.

wood species (Fig. 5). The hardwoods will apparently become superior in form and quality of growth to interplanted pines. Nevertheless, mixed plantations maintain a more rapid diameter growth and give a more complete coverage than pine plantations.

A few areas of strip-mined land have been planted with pure stands of black locust. Early plantings usually have excellent over-all records of survival. In all cases known to the writer, pure stands of trees have grown less rapidly in Western Kentucky than when mixed with other species. Most seem to grow only about two-thirds as fast in pure stands as in mixtures. Nevertheless, pure stands of black locust provide a ground cover in a few years, and the locust borer has not attacked the locust plantings in Western Kentucky to date.

From the variable results obtained in about 5,000 acres in Western Kentucky, mixed plantings are also recommended to minimize the loss caused by the failure of any one specie and to increase the chances of obtaining a dependable supply of seed for natural growths. It is important to have a tree variety which will provide a ground cover and nurse crop in addition to potential timber products.

Grasses and Legumes

Several examples in small-sized and widely diversified areas indicate that higher quality spoil banks, which have a pH of 6 or more, can grow grasses and legumes. Stripped areas often yield good pastures and hay crops when seeded properly. While the chances of failure are greater in seeding with grasses and legumes than with tree plantings, many

failures can be eliminated by determining the best seed mixture, the correct seeding technique, and the optimum time of seeding.

Spoil banks which are rugged, stony, or badly eroded prevent the use of farm machinery necessary to properly maintain the pasture and hay crops after they are seeded. Where grading has been done well, where the soil content is high, and where spoil banks do not contain significant amounts of acid or stony materials, some excellent results have been achieved in revegetating with grasses and legumes.

The average total costs of grading, labor and seed were 45 dollars per acre in 1956 and 1957. Total costs per acre varied, depending upon the amount of grading necessary, the amount of labor required, and the kind of seed mixture used. The grading costs averaged 22 dollars per acre. Seed mixtures were normally composed of Sericea lespedeza, Kobe lespedeza, Kentucky 31 Fescue, and Korean lespedeza. Costs of the seed mixtures averaged 17 and one-half dollars per acre during the 1956-57 season.[8]

[8] Based upon data secured from the Kentucky Strip Mining and Reclamation Commission. Figures stated are costs of state experimental plots near Beaver Dam, Kentucky. Most coal mining companies are reluctant to release reclamation cost figures.

Future Uses

The revegetation of spoil banks in forests and pastures do not exhaust the land use possibilities. A program for developing strip-mined lands into recreational areas has many promising potentialities. Lakes, formed as water collects among spoil banks, may serve as vacation spots. In planning the use of these lands for picnicking, swimming, and fishing, one of the first considerations is that the potential lake sites have accessible locations.

Proper reclamation procedures on spoil banks can accomplish the four-fold purpose of: (1) rebuilding a topsoil; (2) providing a hay, pasture, or forest crop for the future; (3) supplying a suitable habitat for wildlife; and (4) making attractive recreational and home sites with strip-mine lake frontages. Developments during the last five years in Western Kentucky indicate that all four can be wise land uses for 15,000 acres of strip mined lands.

THE RED EMBER COAL MINE: AN ILLINOIS STRIPPING OPERATION

R. D. RUDD
Oregon State College

THE Red Ember strip mine of the Truax-Traer Coal Company[1] is located in west central Illinois 35 miles west southwest of Peoria, Illinois (Fig. 1). The mine began stripping in 1935 and has been in continuous operation since that year. Mine holdings include some 20,000 acres mainly in Joshua, Putnam, Canton, and Buckheart townships of Fulton County, on the western margin of the Illinois coal basin. Mine holdings are not static however; additional land is purchased as stripped-out portions are sold. The company presently owns land that will provide for 15 years of operation and has plans for continual acquisi-

[1] For further coverage of this company see: *Mechanization;* 22:7 (July, 1958) pp. 62-74.

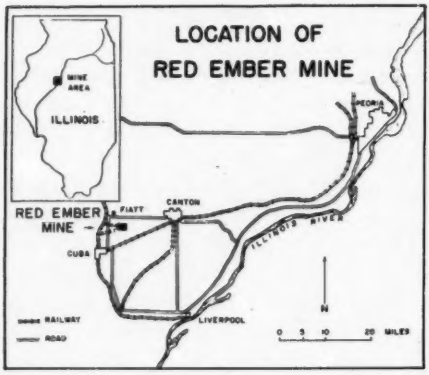

FIG. 1.

tions. Currently three pits are being worked, and total mine production averages 1.5 million tons of coal annually. A more revealing figure, however, is the 7,500 tons of prepared coal which the plant has produced in a one-shift day. Actually, uncovering the coal is a round-the-clock operation here, but coal removal and preparation is done only during the day shift of approximately 8 hours. This includes blasting, hauling to the tipple, washing, grading, and loading the coal into railroad cars.

Personnel and Equipment

Two hundred and ten men are employed in this mining operation including electricians, truck and tractor operators, mechanics, welders, explosives handlers, shovel crews, and those who work in the coal preparation plant.

The Red Ember Mine is an example of the impressive possible production per man where there is a high degree of mechanization. Each worker's effort is multiplied many times by the specialized equipment in use. The operation has the capability of turning out 34 tons of coal per day per man—mined, graded, washed and loaded.

Mining and transporting equipment includes six 25 ton and eleven 45 ton coal hauling units, 11 caterpillar tractors (D6, D8, and D9) for use in the pits and for grading stripped land, 2 road graders, a 7 cubic yard electric coal loading shovel, a 950B shovel, and a 954WX wheel excavator. The last two units merit some description as remarkable examples of multiplying man's effort by machines.

The 950B shovel is a 1,460 ton electrically driven machine which has been in operation at the mine since 1937. It is used chiefly to remove the bedrock portion of the overburden after the rock has been shattered by explosives. The highest point on the machine is at the end of a 110 foot beam, the end of which stands 117 feet above the ground. Suspended from this beam by a 72 foot dipper handle is a 33 cubic yard bucket. A 125 ton pig iron counterweight balances the full bucket as the machine swings around to dump its load of broken rock onto the spoil bank. The shovel is mounted on 4 great caterpillar treads and is self-propelled.

The wheel excavator[2] is designed to simultaneously dig the unconsolidated upper layer of overburden, transfer it to a conveyor system, and deposit it onto a spoil bank (Fig. 2). The wheel dumps its load of soil and subsoil on top of the spoil pile of dumped bed rock made during an earlier pass by the shovel and thus approximates the original relative position of these materials. With rock as the lowermost layer, the spoil bank is less apt to spread out on the uncovered coal. In addition, this arrangement facilitates grading and agricultural reclamation of the stripped land.

The Truax-Traer wheel consists basically of a digging apparatus (The Wheel) and a conveyor system, both of which are mounted on a self-propelled chassis. The wheel has a diameter of 24 feet and

[2] For further coverage of this machine see: "Wheel Excavator Speeds Stripping at Truax–Traer" *Mining Congress Journal;* 41:6 (June, 1955) pp. 74-79.

is equipped with 9 "buckets." The term bucket here refers to a rectangular metal frame with teeth on the unattached end and 9 rows of heavy chains forming the container part of the bucket. As the wheel rotates, each bucket digs about a cubic yard of material on the upswing. No preparation of the unconsolidated material is required. There is a digging force of 47,000 pounds at the bucket mouth.[3] As the bucket reaches the top of its rotation circle, the chains slump forward, releasing their load onto the conveyor system. The fact that the chains are loosely stretched across the bucket frame allows them to accumulate a larger load and to shake it loose readily. The digging wheel is mounted on a vertically and horizontally adjustable frame. This allows the chassis to remain in one place while the wheel ranges over all the material within reach. The machine was made especially to fit the situation at the Red Ember mine; the wheel can reach from ground level down to the bedrock level, in most cases without special adjustment.

The conveyor system has a total length of 355 feet, sufficient to reach from the high wall to the spoil banks beyond a significant expanse of uncovered coal. Basically there are 2 units to the conveyor system, the end portion being adjustable. In order for the material coming off the end of the conveyor to be spread along the spoil bank without pivoting the whole machine, the end section swings through a more or less horizontal arc. The wheel excavator works continuously, stopping only for servicing, repair, or movement to another section of the mine. During one year of operation the machine averages a removal of 1,510 cubic yards per hour of operation.[4] By comparison, a 2.5 cubic yard short boom drag line bucket, one of the larger sizes, is capable of moving 300 cubic yards an hour.[5] This figure gives only an approximate comparison however. It represents ideal conditions of removal and movement of the material a shorter distance than with the wheel.

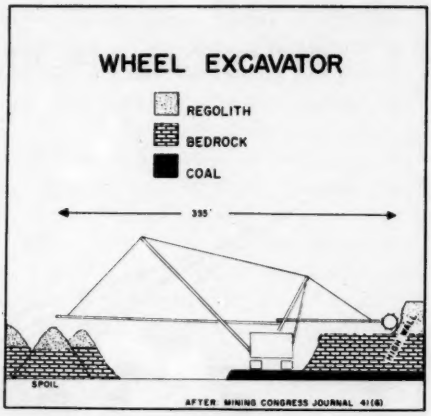

FIG. 2.

Mining and Processing

Although the wheel and the 950B shovel operate continuously, the work day for most of the men begins between 7:00 a.m. and 8:00 a.m. Blasting of the coal, stripped of its 75 feet of overburden, goes on during the workday. The charge required to break up the coal is not particularly large; 50 per cent dynamite sticks, 2 inches in diameter and 12 inches long, are placed in holes drilled 12 feet apart by an auger mounted on the back of a jeep. The explosions are quite unspectacular and can hardly be heard over the noise of diesel trucks, the loading shovel, and other equipment operating in the same area. The explosion simply loosens the coal so that the coal loading shovel can scoop it up and dump it into the 25 and 45 ton transporting units. The latter move between the pit

[3] *Ibid.*

[4] Personal communication, Gene Long, Superintendent, Red Ember Mine.

[5] "Functional Design, Job Application, and Job Analysis of Power Cranes and Shovels," *Power Crane and Shovel Assoc. Tech. Bull. No. 1*, 1958, p. 32.

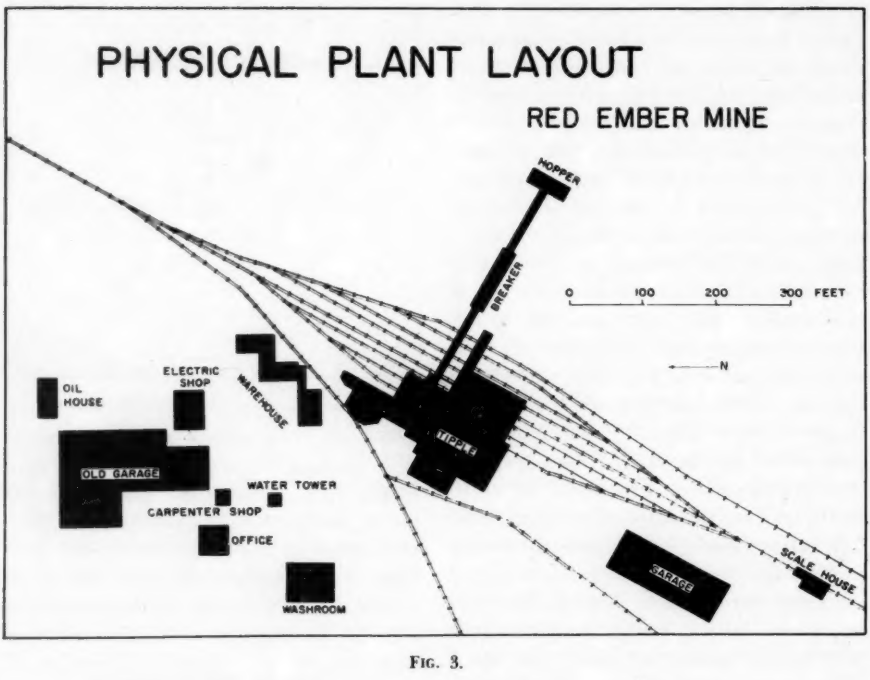

FIG. 3.

and the processing plant from 7:00 a.m. until about 3:00 p.m. the average round-trip of 7 miles requiring 30 minutes.

At the processing plant the coal is dumped by gravity into a 180 ton hopper (Fig. 3). It moves by conveyor belt from the hopper to the classifier shed. There, the largest pieces are removed from the conveyor system by screening and then broken up in a rotary breaker before continuing into the processing plant. Large pieces of rock are removed here also.

Coal entering the processing plant includes pieces varying in size from 6 inches in diameter to coal dust particles. Further subdivision into two categories is effected by passing the coal over a series of bars 2 inches apart. The sized coal then moves through the wash boxes where remaining rock wastes and "fines" are removed.

Separation of the rock waste from the coal is accomplished by making use of the density contrast between the two materials. The incoming coal and waste materials are partially suspended in water as they move through the wash boxes. Agitation of the mixture by pistons results in a layering effect with the heavier rock waste settling to the bottom from whence it is drawn off.

Movement through the wash boxes also separates the fines from the larger pieces in that the former stay in the water as it leaves the wash boxes. Recovery of the fines fits in with processing the water for re-use, an important economic factor in this plant where an average of 10,000 gallons per minute are used during the work shift. Both are accomplished by pumping the water into a settling basin, 55 feet in diameter and 3 stories high and shaped like an inverted cone. The water enters the full basin at water level in the center. By the time it has moved to the edges, all but the finest particles have settled below

the surface. Around the edge of the cone the surface water is drawn off and returned to the wash boxes. The apex of the inverted cone is tapped periodically, and the fines thus obtained are dried for use by the plant or for sale.

The washed and graded coal goes by conveyor to bins above the loading tracks. Railroad coal cars are run under the bins, gravity-loaded, and moved out again throughout the work day.

Marketing

The coal mined at the Red Ember Mine is bituminous coal and is used primarily as steam coal. Public utility power stations in northern Illinois consume approximately 50 per cent of the output. Another 40 per cent goes to industries for power generation and heating, while the remaining 10 per cent serves the domestic market.

The chief market area is along the Illinois River. Coal moves away from the mine via the Chicago, Burlington and Quincy Railroad, but much of it goes only 20 miles to the loading docks at Liverpool, Illinois. From Liverpool, which is 30 miles downstream from Peoria, the coal moves by barges of the Mississippi Valley Towing Company and the Ohio River Towing Company to its destination. In recent years an annual average of 800,000 tons has been moved to market this way. Peoria is the major center served by rail instead of barge due to a favorable freight rate and a short haul.

Although this operation has not resulted in the development of a specific community, it has been a significant factor in the economic structure of the surrounding area. Most of the workers live in the vicinity or commute from nearby small towns. A number of them farm on a part-time basis, some on land that has been stripped and graded.

Many large strip-mining companies now profitably practice reclamation of the stripped land in one way or another. At this mine, much of the stripped land is graded until steep slopes are eliminated. A deliberate effort is made to approximate the original terrain. Much of the land recently sold by the Red Ember Mine has been seeded with a mixture of alfalfa, sweet clover, brome, and timothy. Sudan grass often is planted and then turned under to add humus. After a few years of such treatment some of these fields have been planted to wheat and even corn. Yields are extremely variable. With grading, most of the land can be sown to and used for pasture. This is, in fact, one of the chief uses to which stripped land in Illinois has been put in recent years.[6]

Other uses of stripped land from this mine include growing of timber and orchards and creating recreational areas and homesites. Many residents of Peoria and other Illinois cities have purchased lots and built attractive homes on this land.

[6] Personal communication. L. S. Weber Ass't Director of Conservation, Midwest Coal Producers Institute, Inc.

What Is The National Council?

The National Council for Geographic Education was organized in 1914 to promote and advance geographic education in the public schools and colleges of the United States.

To achieve its purpose the National Council for Geographic Education has sponsored and will continue to sponsor many worthwhile projects. The organization particularly wishes to improve instruction in geography and the social studies and to encourage research in all phases of geographic education at each grade level, as well as in college and graduate school work.

By carrying out its program, the Council hopes to foster geographic understandings and to increase the effectiveness of the teaching of geography.

THE INDIA-CHINA BOUNDARY DISPUTE*

PRADYUMNA PRASAD KARAN
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THE SMOOTH functioning of an international boundary depends as much on the general political situation, attitude and policy of the states involved as on the details of delimitation and demarcation. "Given no check on national sovereignty, all international borderlands are potentially critical."[1] The history of the India-Tibet boundary and recent events on this international frontier illustrate the reality of the above concept. India's northern frontier, which was stable for a long time, has now become potentially critical with the exercise of unrestricted sovereignty over Tibet by Communist China (Fig. 1).

The change in the general political situation in Tibet due to Communist occupation has led to recent boundary frictions; as a result of these disputes Red China, a giant nation in the Communist sphere, and India, potentially an important power in the free world, have moved away from positions of avowed mutual regard of peaceful coexistence. Two major causes of this boundary friction, which seems to threaten peace and security in Asia, are the Chinese territorial claims on Indian frontier areas and restriction on travel and trade across the boundary. Before analyzing the functions and problems of the India-Tibet boundary, it may be useful to summarize briefly the changing role of the Himalayan frontier.

Changing Role of the Himalayan Frontier

Sixty years ago Holdich pointed out that "the greatest snow-peaks and glaciers of the world are piled on the summits of this vast crystalline axis of the Himalaya. Could anything be better than this magnificent array of unapproachable snow and ice to serve as the unmistakable barrier between two vast Asiatic countries?"[2] Undoubtedly, for ages the northern snow-capped ranges of the Himalayas stretching in an unbroken sweep from Kashmir to Assam have constituted a formidable barrier frontier.[3] Because of the great height of the mountains, the landward connections with Tibet are limited to a few mountain passes which have resounded with the prayers of Buddhist Lamas and tinkling bells of small trading columns. Each year tides of Tibetan traders have come across the high passes into India in spring and have returned to Tibet before the approach of winter. Indeed this has been one of the few places in the world where there has been free trade and travel across an international frontier since ancient times. Caravans carried cloth, spices, and small manufactured goods from India into Tibet, and brought back salt, wool, and sometimes herds of yak. Cooperation between Tibet and India and the absence of much governmental activity into affairs of the Tibetans permitted harmonious functioning of the boundary. The tempo of life had continued much as it had for hundreds of years until the Communist occupation of Tibet in 1951. Now the unrestrained Chinese sovereignty over Tibet and the intimate participation by the Communists in the internal affairs of

* This study was supported by the University of Kentucky Faculty Research Fund.

[1] Stephen B. Jones, *Boundary-Making: A Handbook for Statesmen, Treaty Editors and Boundary Commissioners,* Carnegie Endowment For International Peace, Washington, 1943, p. 3.

[2] Thomas Holdich, "The Use of Practical Geography Illustrated by Recent Frontier Operations," *Geographical Journal,* Vol. 13, 1899, pp. 465-80, reference on pp. 469-70.

[3] K. M. Panikkar, "The Himalayas and Indian Defence," *India Quarterly,* Vol. 3, 1947, pp. 233-238, reference on p. 237.

NORTHERN FRONTIER OF INDIA
LEGEND
INTERNATIONAL BOUNDARY
BOUNDARY OF CHINA AS SHOWN ON THE CHINESE AND SOVIET MAPS
INDIAN STATE BOUNDARIES
INDIAN TERRITORIES CLAIMED BY RED CHINA
50 0 50 100 150 200 250 300 350 MILES
McMahon Line (1914)
CHINA
TIBET
INDIA
PAKISTAN
NEPAL
SIKKIM
BHUTAN
BURMA
U.S.S.R.
AFGHAN.
YARKAND
KHOTAN
KUNLUN MOUNTAINS
KARAKORAM PASS
GILGIT
SRINAGAR
JAMMU
KASHMIR
JAMMU AND
SHIPKI PASS
GARTOK
SIMLA
CHANDIGARH
DELHI
JAIPUR
LUCKNOW
PUNJAB
UTTAR PRADESH
RAJASTHAN
BIHAR
HIMALAYA MTS.
LHASA
SHIGATSE
GYANGTSE
KATMANDU
PUNAKHA
GANGTOK
DARJEELING
WEST BENGAL
GAUHATI
TUENSANG
PRADYUMNA P. KARAN

FIG. 1.

Tibet are reflected in restrictions on movement of pilgrims and traders across the boundary. The rights of trade and pilgrimage in Tibet held by India since historic times have been steadily whittled away by Chinese action. Obstacles have been put in the way of traders. Pilgrimage to the Tibetan holy places has been abrogated by a warning to would-be pilgrims not to enter Tibet for the People's Liberation Army will be conducting military operations and cannot assure the safety of foreigners.

The smooth functioning of the India-Tibet boundary has become difficult and, backed by militant Communist-occupied Tibet, the barrier role of the Himalaya has changed. In the present situation the Himalayan frontier is no longer formidable as stressed by Holdich six decades ago. From modern military bases in Tibet the Red Chinese can deliver continuous air attack on the densely populated Ganges Valley and the industrial areas of Bihar-Bengal. The militant Red Chinese government, dedicated to the Communist doctrine of world domination, has altered the traditional barrier effect of the Himalayan rampart.[4] Thus, despite their immense height, the Himalayan ranges are no longer a very effective frontier barrier today.

Boundary Problems

The India-Tibet boundary, called the McMahon Line, is defined in general terms in a 1914 treaty to which Tibet, Great Britain and China were parties.[5] The boundary is not demarcated on the ground, and for several years the Chinese Communist maps had shown areas south of the McMahon Line in Assam, Uttar Pradesh and the Ladakh region of India inside Chinese territory. At first India did not pay much serious attention to these maps. In 1950 the Prime Minister of India declared in the Indian Paliament that "the McMahon Line is our boundary, map or no map. . . . We will not allow anybody to come across the boundary."[6] In 1951 India officially brought to the attention of China the cartographic error in showing the boundary as running parallel to the Brahmputra river when it actually follows the crest line of the Great Himalaya. China responded with the plea that the old maps were not updated and asked India "not to pay slightest attention to these maps."[7] However, despite India's protest the maps in the new *Atlas of Chinese Peoples' Republic* published in 1953 and the Russian *Atlas Mira* published in 1954 continued to include four divisions of India's North East Frontier Agency, some areas on the north of the state of Uttar Pradesh and large areas in eastern Ladakh within China (Fig. 1). In Assam alone about 22,600 square miles of Indian territory are shown as part of China on the Soviet and Chinese maps.[8]

During the last five years there has been continuous friction with China along the border.[9] The disputes began in 1954 with the Chinese protest that Indian troops were in possession of Chinese territory in the area which India re-

[4] K. M. Panikkar, *Geographical Factors in Indian History*, Bombay, 1955, p. 54.

[5] S. Whittemore Boggs, *International Boundaries: A Study of Boundary Functions and Problems*, Columbia University Press, New York, 1940, p. 145.

[6] Parliament of India, *Parliamentary Debates, Official Reports*, Vol. 5, No. 4. Part 1, November 20, 1950, New Delhi, 1950.

[7] Jawaharla Nehru, *Press Conferences*, India Information Services, New Delhi, 1951, p. 68.

[8] Area measured by planimeter from Russian and Chinese maps. This figure generally agrees with the Government of India calculations (22,000 square miles) made public in New Delhi on September 7, 1959. See *New York Times*, September 9, 1959.

[9] A full account of all the border disputes and clashes with Chinese troops up to the present are given in 125-page *White Paper* (official report) presented to the Parliament of India on September 7, 1959. For a short report see *New York Times*, September 8, 1959.

garded as marking the frontier with China in Garhwal district of Utter Pradesh. In the beginning these border frictions were taken to be minor misunderstandings resulting from patrols meeting in poorly charted territory, but later they came to be recognized clearly as clashes of mutually exclusive territorial claims. In November, 1958, Red China proposed that surveys and negotiations for redrawing of the Sino-Indian boundary would be undertaken[10] to which India replied that her Himalayan border, the McMahon Line, was well known and would not be subject to change, and termed the publication of maps showing Indian territory as Chinese "an affront to India."[11] Now China has indicated that it no longer accepts the permanence of borders between China and her neighbors, including India, and considers these boundaries subject to "survey" and consultation with "the countries concerned."[12]

At the heart of the present boundary problem is China's refusal to recognize the 1914 treaty with Tibet which fixed the McMahon Line. Therefore, it may be useful to comment briefly on the status of Tibet at the tripartite conference among Great Britain, Tibet and the Chinese Republic held at Simla, India, in 1913-14, which established India's boundary with Tibet.

In the twentieth century much controversy has centered around the international status of Tibet—whether China had suzerainty or sovereignty over Tibet. The Chinese control of Tibet ebbed and flowed with the changing fortunes of the Government in China proper. When the Government in Peking was strong, such as at the height of Manchu dynasty, its control over Tibet waxed. But when the military power of China waned, especially in the nineteenth century, their grip over Tibet loosened. Yet it is important to note that the Chinese were never able to control Tibet as firmly as other provinces, and Tibetans never willingly accepted Chinese overlordship. The British Government has long recognized vague Chinese suzerainty over Tibet, but the Chinese have always claimed sovereign rights in Tibet.[13]

The problem of Chinese sovereignty versus suzerainty over Tibet was in effect the problem of to what extent China could exercise her control over a distant and mountainous region which continually tried to shake off her overlordship. For instance, between 1912-1951 Tibet functioned as a *de facto* independent country, and there is little evidence that China even enjoyed suzerain rights during this period.[14] Both Britain and China maintained missions in Lhasa, and Tibet operated its own Foreign Affairs Bureau during World War II. Tibet claimed herself as a *de jure* independent nation in her 1950 appeal to the United Nations against Chinese invasion.

Towering on the world's highest plateau, isolated Tibet enjoyed full independence in modern times until the Communists occupied the country in 1951.

In conclusion, it may be said that Tibet participated in the 1913-14 Simla Conference as a virtually independent country in equal status with China. The Tibet-India boundary agreement written at the Simla Conference and the maps marking the boundary were rati-

[10] *New York Times*, December 1, 1958.
[11] *New York Times*, September 6, 1959.
[12] *The Times*, London, September 8, 1959, p. 8.

[13] For short survey of Tibet's relation with China and Britain see E. T. Williams "Tibet and Her Neighbors" *University of California Publications, Bureau of International Relations*, Vol. 3, No. 2, 1937, pp. 99-140.

[14] Mark C. Feer, "Tibet in Sino-Indian Relations," *India Quarterly*, Vol. 9, No. 4, 1953, p. 271; See also Roy Mellor, "The Changing Geographical Value of Tibet," *The Scottish Geographical Magazine*, Vol. 75, No. 2, September 1959, pp. 113-115.

fied by Tibet in 1914,[15] but were not ratified by the Chinese Republic. It is said that the Chinese Government refused to ratify the agreements reached at Simla because of their objection not to McMahon Line boundary between India and Tibet but to the proposed line of demarcation between Inner Tibet, which was under Chinese administration, and Outer Tibet, which was to be administered from Lhasa. In any case the McMahon Line was accepted as the boundary by the authorities in control of the territories on either side of it. It should be clearly understood that the McMahon Line following the crest of the Great Himalayan Range is a physical boundary, and it has become firmly established by custom and usage.

When the boundary agreement was reached it was not considered essential or even practical to demarcate the boundary on the surface. Sir Henry McMahon, the chief negotiator for British India at the 1914 treaty for whom the boundary is named, commented as follows on the demarcation of the boundary: "That portion, however, which for some five hundred miles formed the boundary between India and Tibet, owing to our greater local knowledge and more detailed survey, supplemented by the results of special survey parties sent out to examine the less known areas, admitted of more detailed and exact definition. For greater lengths of it lofty mountain ranges and watersheds buried in eternal snow facilitated verbal definition and rendered demarcation on the ground (except in a few small special and more inhabited areas) either impossible or superflous."[16] The explorations of Sir Charles Bell, Britain's adviser at the Simla conference, provided sufficient information to identify the boundary in general terms. On a map Bell marked out the McMahon Line which was subsequently agreed to with small modifications by the Tibetan and Chinese delegates.

While India regards the McMahon Line as her legal northern boundary since the 1914 treaty, Red China refuses to honor the agreement and maps ratified by Tibet, and it does not recognize the McMahon Line drawn along the crest of the Himalaya as the border between India and Tibet. In the Communist view the McMahon Line was a "product of British policy of aggression against the Tibet region of China."[17] In not recognizing the 1914 treaty, the Chinese have followed the usual Communist pattern of disregard for international agreements and conventions. Also, Communist China, by claming portions of territory on the Indian side of the McMahon Line, has contravened the cardinal principle of "mutual respect for each others territorial integrity and sovereignty"[18] contained in the Sino-Indian treaty of 1954.

Possibly, the chief aim of Communist China in challenging India's Himalayan frontier is to bring under Chinese control all the centers of Lamaistic Buddhism which continue to regard the spiritual authority of the Dalai Lama; as long as any of these remain beyond their reach, Tibetan nationalism cannot be decisively crushed. Undoubtedly a second purpose is to impress the Chinese

[15] Government of India. *A Collection of Treaties, Engagements and Sanads Relating to India and Neighbouring Countries,* XIV. Prepared by C. U. Aitchison, Calcutta, 1929, p. 34.

[16] A. Henry McMahon, "International Boundaries," *Journal of the Royal Society of Arts,* Vol. 84, 1935, pp. 2-16, reference on pp. 12-13. For an illustrated account of the terrain in this frontier area see the following paper by Tribal Adviser to India's North East Frontier, Verrier Elwin, "The Dalai Lama Comes to India," *Geographical Magazine,* Vol. 32, No. 4, 1959, pp. 161-169.

[17] *New York Times,* September 8, 1959.

[18] Hsinhua News Agency. *Daily News Release,* April 30, 1954.

people with a display of the Communists' patriotic zeal in revising a frontier which was established without China's formal consent. A third motive may well be a desire to demonstrate, for the benefit of everyone in south and southeast Asia, that China is stronger than India and can force the Indian government to give way.

India's startling reversal of mood toward Communist China arising out of the Sino-Indian boundary problem is undoubtedly a significant geopolitical development. It seems only yesterday that the enormous weight of India's huge population appeared to lean heavily toward China and Soviet Union. That this no longer is so is a fact of more than casual interest to the United States and indeed to the whole free world. India has now been put on guard against Communist ambitions in the strategic Himalayan region, and this realization of the threat to India is likely to color the country's international outlook. It seems that there is little possibility of a major conflict with China because of the difficult terrain and India's determination to solve the dispute by peaceful means, but the boundary question will continue to disturb relations between the two great Asian nations.

RAILROADS OF SOUTHEAST ASIA*

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AFTER 75 years of railway construction, there is still no rail network linking all the countries in continental Southeast Asia. In this large area of some 800,000 square miles, embracing the countries of Thailand, Burma, Malaya, Laos, Cambodia, North Viet-Nam, and South Viet-Nam, there are two small open nets and one rail line that formerly connected with the railway system of continental China (Fig. 1).

The latter line served French Indo-China, but much of it was destroyed during a war for independence and later a civil war. Trains no longer travel across the boundary between the two Viet-Nams.

One of these open nets is limited to the boundaries of Burma.

This paper will treat the larger of the two small rail nets serving Thailand, Malaya, Cambodia, and Laos.

Extent

In 1957, the rail lines linking Malaya, Thailand and Cambodia measured approximately 3,701 miles.[1] This net serves the four capitals of Krung Thep (Bangkok),[2] Kuala Lumpur, Phnom Penh, and Vientiane as well as the three big ports of Krung Thep, Penang, and Singapore. With 2,157 miles of railways in opera-

* Except for Figure 2, the maps in this paper were drawn by Emmitt Christian who was paid with funds from the Indiana University Research Fund. Beatriz Rey, a geography graduate, drafted Figure 2.

This article was presented as a paper in an abbreviated form at the 55th Annual Meeting of the Association of American Geographers held in Pittsburgh, April, 1959.

The writer was a Visiting Professor of Geography and Social Science at the College of Education, Krung Thep, Thailand, between June, 1955, and May, 1957.

[1] United Nations. *Economic Survey of Asia and the Far East, 1957*. Bangkok, Thailand, 1948, p. 202.

[2] Krung Thep is used rather than Bangkok to refer to the capital of Thailand in order to be consistent with the spelling of other Thai locations in this paper.

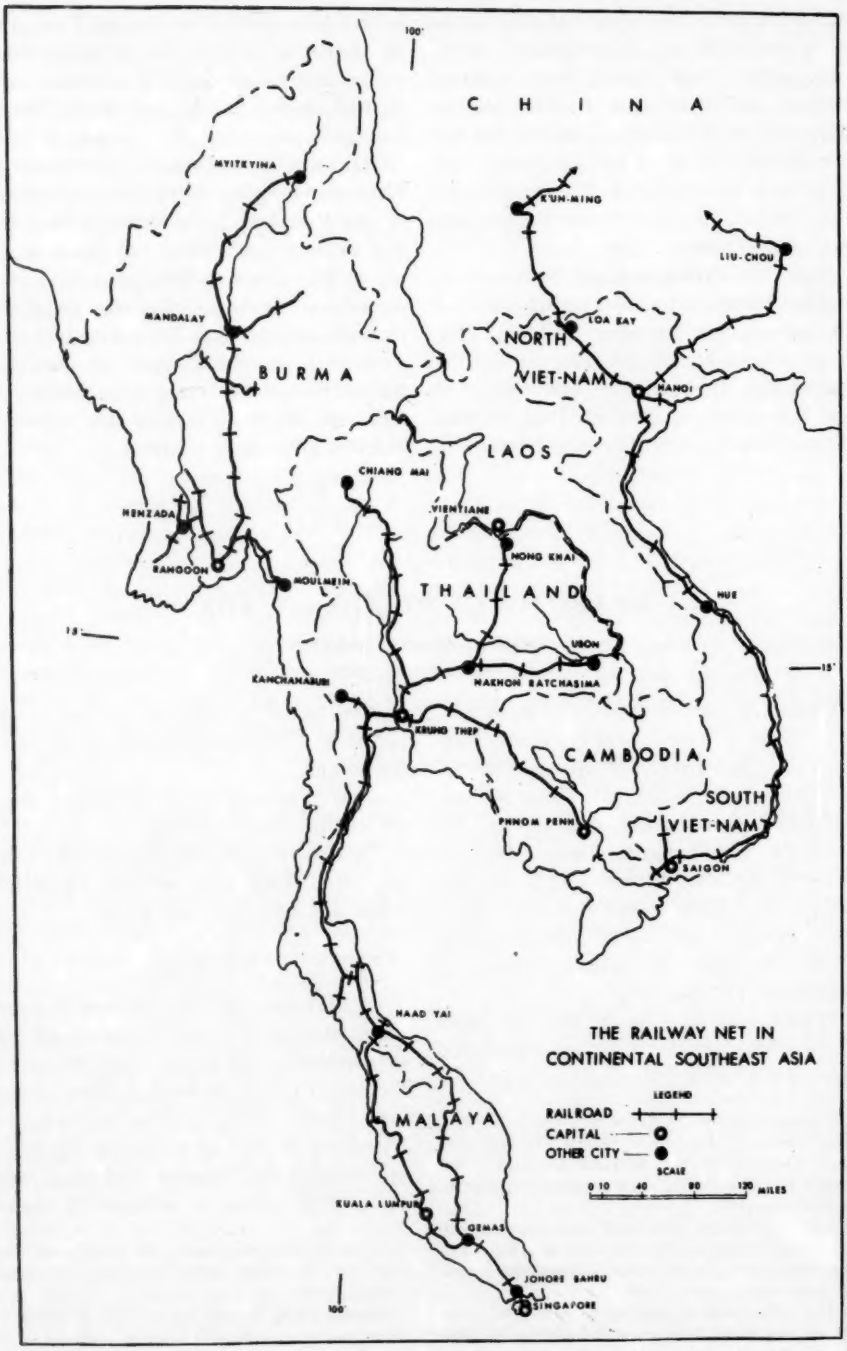
CHINA
MYITKYINA
KUN-MING
LIU-CHOU
MANDALAY
LOA KAY
NORTH
VIET-NAM
BURMA
HANOI
LAOS
CHIANG MAI
HENZADA
VIENTIANE
NONG KHAI
RANGOON
MOULMEIN
THAILAND
HUE
UBON
NAKHON RATCHASIMA
KANCHANABURI
KRUNG THEP
CAMBODIA
SOUTH
VIET-NAM
PHNOM PENH
SAIGON
HAAD YAI
THE RAILWAY NET IN
CONTINENTAL SOUTHEAST ASIA
LEGEND
RAILROAD
CAPITAL
OTHER CITY
SCALE
0 10 40 80 120 MILES
MALAYA
KUALA LUMPUR
GEMAS
JOHORE BAHRU
SINGAPORE

FIG. 1.

tion, or over three-fifths of the total mileage, Thailand has the largest system in Southeast Asia. In contrast, Malaya has 1,304 miles in operation; Burma, 691 miles.[3] There are only 240 miles in Cambodia and none in Laos.

Goods and passengers destined for Vientiane may enter the Krung Thep seaport and travel over the Thai railways to Nong Khai, a distance of 383 miles. From here, passengers and freight are ferried across the Mekong River and continue about 12 miles to Vientiane by bus and truck.

The greatest north-south length of this open net is about 1,653 miles. The longest line in this direction extends from Singapore to Krung Thep, via the Padang-Besar Joint Station, a distance of approximately 1,197 miles and on to Chiang Mai, 453 miles farther north.[4] In order for a passenger to travel this distance, he needs to change trains at Krung Thep.

The greatest east-west extent of these lines is about one-third of the lines' length (519 miles). A line extends westward from Phnom Penh about 400 miles to Krung Thep and on to Kanchanaburi about 121 miles farther west. Train service to Wang Po northwest of Kanchanaburi was discontinued in 1957.

This net was much larger during the Second World War when the Japanese connected the railways in Thailand with those in Burma (Fig. 1). In Thailand, the Japanese built a completely new line from Nong Pladuk Junction 40 miles from Krung Thep on the Southern Line to Three Pagodas Pass, a distance of about 187 miles. This line followed a northwest direction from Nong Pladuk Junction through the valley of the Gwe Noi River to where the line crossed the international boundary at the Three Pagodas Pass. It continued in a northwest direction in Burma to Thanbyuzayat and Moulmein.[5] This railroad was later known as the Railway of Death. Some of the reasons this line proved unsatisfactory were that: (1) it was poorly constructed; (2) severe Allied bombings damaged many sections of the roadway; (3) soon after its completion, the Japanese were forced to leave Southeast Asia; and (4) it crossed unproductive mountainous terrain. After the war, the British pulled up part of the connecting link to a point approximately four miles south of the Three Pagodas Pass.[6]

The extent of this net is related to the topography of the area. Today it is chiefly confined to the plains within the horse-shoe-shaped rim of mountains and hills which surround Thailand, Laos, Cambodia, and South Viet-Nam and partially separate these countries from the rest of Asia (Fig. 2). There still is no rail service across this rim of hills and mountains, although, during the Second World War, the Japanese not only crossed this rather formidable barrier at the Three Pagodas Pass but also carried a line across the Kra Peninsula (Fig. 3). The French built a rail line along the east coast of French Indo-China, also crossing this rim to connect Hanoi with Saigon.

Contrary to some published reports, a rail line was never constructed between Phnom Penh and Saigon. In the last decade of the nineteenth century, French plans for railway construction in French Indo-China included a rail line connect-

[3] United Nations, *loc. cit.* This information refers to 1955; apparently data for 1957 was not available. During the past decade, repeated annual bombings have severely damaged and interrupted rail service. The 1931 census report for Burma listed 2,060 miles of line.

[4] Data included in a letter from Ahna Ramyanada, Chief Administrative Officer, State Railways of Thailand, dated June 17, 1957.

[5] Rees Rawson, "Two New Railways in Southeast Asia," *Geographical Journal,* Vol. 108, 1946, 85.

[6] Thailand, Ministry of Communications. *Royal State Railways of Siam.* (Bangkok: Royal State Railways Printing Office, 1947), p. 16.

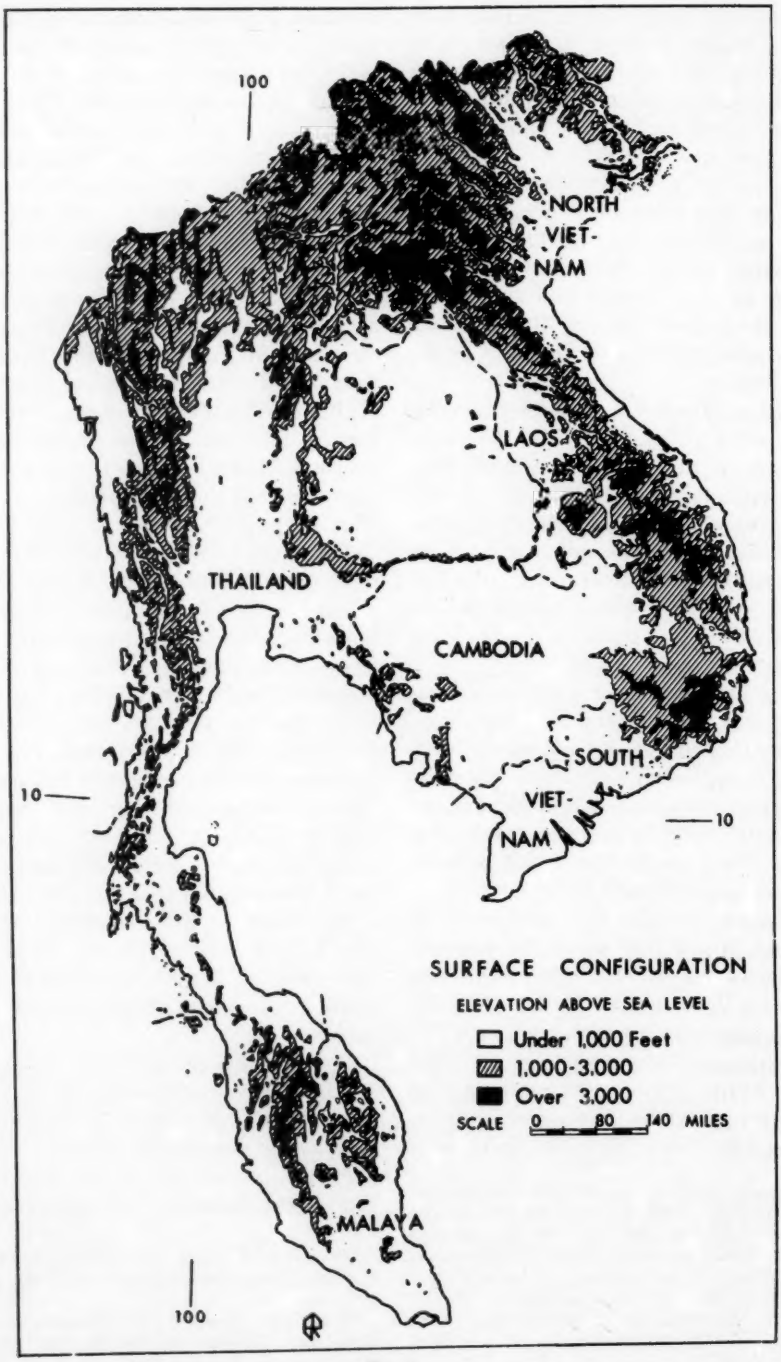
100
NORTH VIET-NAM
LAOS
THAILAND
CAMBODIA
SOUTH VIET-NAM
10
10
SURFACE CONFIGURATION
ELEVATION ABOVE SEA LEVEL
Under 1,000 Feet
1,000-3,000
Over 3,000
SCALE 0 80 140 MILES
MALAYA
100

FIG. 2.

ing the two river ports of Saigon and Phnom Penh. The rails for such a line would have had to cross the flood plain, delta and distributaries of the Mekong River. The cost and maintenance of a railway high enough to be above flood waters in the wet season and across such low swampy land would have been enormous. Such an undertaking is still not considered feasible, since boats of 1,500 and 2,500 tons can operate throughout the year between Phnom Penh and the coast.[7] In fact, the operation of the railway south of Saigon proved uneconomical and was discontinued in favor of water and highway transportation.[8]

Thailand has a greater total mileage of railways than Malaya. But, if ratios of mileage to area and population are considered, Malaya has greater mileage than Thailand. Malaya has one mile of railways for each 39 square miles of area, whereas Thailand has only one mile for each 97. In Malaya there are 4,814 persons for each mile of railways; in Thailand for each mile there are 9,775. It should be remembered that the latter has many more miles of navigable rivers and canals.

Pattern

Lines serving Thailand, Malaya, Cambodia, and Laos do not form a web pattern. Instead, a few main lines reach out from Krung Thep in all directions (Fig. 1). They resemble more the appendages of the spider rather than its web. The main railways bifurcate in several places, but their large branches and the short spurs are one-way lines terminating at either seacoast or interior cities.

[7] United States Department of Commerce, *Basic Data on the Economy of Cambodia* (Washington: U. S. Government Printing Office, 1958), p. 6.

[8] Seventh Annual Report of the Consultative Committee, *The Colombo Plan for Cooperative Economic Development in South and Southeast Asia* (Washington: U. S. Government Printing Office, 1958), p. 160.

The short dead-end feeders are concentrated in peninsular Thailand and in Malaya. Only one main line links Krung Thep to Malaya (Fig. 3). This line south of Surat Thani was built near the center of the peninsula instead of following either coast where most of the cities are located. Had it been located near the east coast, it would have been necessary to build expensive embankments and bridges across extensive wet-season swamp lands, intermittent lakes, and swollen rivers. Physical barriers hindering the building of a line along the west coast were mangrove swamps, drowned river valleys, a discontinuous coast plain, and numerous hills which abut on the coast. Spur feeders connect the large east coast cities such as Nakhon Si Thammarat and Songkhla to the main line. Only one spur has been built to the west coast and it terminates at Kantang, a river port. Phuket, the economic regional capital of west coast peninsular Thailand, has no rail connections.

Five short spurs join the Malayan coastal cities with the country's two main lines. Here, in contrast with the situation in peninsular Thailand, all the short feeder lines but one are on the west side. These connect Port Dickson, Port Swettenham, Telok Anson, and Port Weld with the West Coast Line. Historically, these were the first railways built in Malaya and led from the coastal ports to mines and towns in the interior.[9] The West Coast Line was developed later to connect the interior mining towns. Only one short spur connects Tumpat with the East Coast Line (Fig. 3).

In contrast with the tenacle-like pattern eptomizing the general picture of railways in continental Southeast Asia, in Malaya and peninsular Thailand the

[9] C. A. Fisher, "The Railway Geography of British Malaya," *Scottish Geographical Magazine*, Vol. 64, 1948, 125.

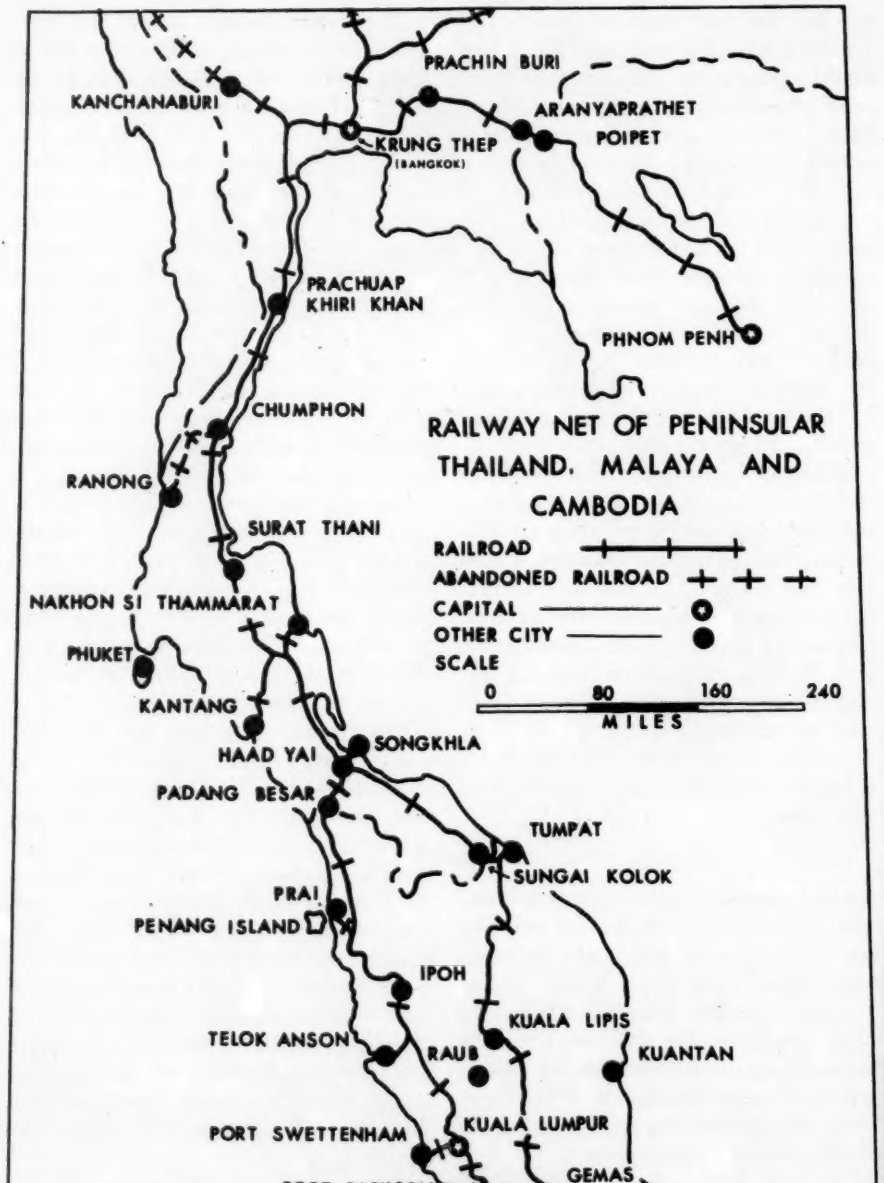
PRACHIN BURI
KANCHANABURI
ARANYAPRATHET
KRUNG THEP
(BANGKOK)
POIPET
PRACHUAP
KHIRI KHAN
PHNOM PENH
CHUMPHON
RANONG
SURAT THANI
NAKHON SI THAMMARAT
PHUKET
KANTANG
HAAD YAI
SONGKHLA
PADANG BESAR
TUMPAT
SUNGAI KOLOK
PRAI
PENANG ISLAND
IPOH
KUALA LIPIS
TELOK ANSON
RAUB
KUANTAN
PORT SWETTENHAM
KUALA LUMPUR
PORT DICKSON
GEMAS
MALAKKA
JOHORE BAHRU
SINGAPORE
RAILWAY NET OF PENINSULAR THAILAND, MALAYA AND CAMBODIA
RAILROAD
ABANDONED RAILROAD
CAPITAL
OTHER CITY
SCALE
0 80 160 240
MILES

Fig. 3.

pattern is one large "loop" or "circular" line (Fig. 1). In Malaya the rail system consists primarily of two main lines, the West Coast and the East Coast. These extend nearly the full length of the country and are located on the west and east sides respectively of the hilly and mountainous core (Fig. 3). These lines use the same track from Singapore to Gemas, then bifurcate, and do not meet again until they reach Haad Yai in Changwat (province) Songkhla, Thailand.

International Cooperation

This international railway net connects three different countries and has a uniform meter gauge, but it does not function as one system but three. There are five cities near the borders where breaks in transportation occur (Fig. 3). These are: Padang Besar, Prai, and Sungai Kolok, all near the Thai-Malayan border; Poipet, near the Thailand-Cambodian border; and Nong Khai, near the Thailand-Laotian border.[10]

Thailand-Malayan cooperation. In spite of the fact that the most efficient passenger and freight service is between Thailand and Malaya, the facilities are still not used to their greatest capacity. People going from Krung Thep to Singapore may occupy coaches (called buggies) which are a part of a Thai train called the "International Express." At Padang Besar they go through customs, then continue to Prai, near Penang, the latter an island and free port. From here, one may travel in the same coaches now a part of a Malayan train to Singapore. This service was interrupted during the Second World War and reinstated in January, 1954. Today, as before the war, the "International Express" maintains its twice weekly schedule.

On the eastern side of the peninsula, Sungai Kolok is the international terminal. The distance between Krung Thep and Singapore through Sungai Kolok is 1,184 miles, or 13 miles shorter than that through Padang Besar. This route is not popular because more changes are necessary. Passengers going from Singapore to Krung Thep over the East Coast Line travel in coaches detached at Gemas from the "International Express" and joined to the "Golden Blowpipe Express." This train continues to Sungai Kolok, where the passengers change to a Thai train going to Haad Yai. At Haad Yai, they change again to the "International Express."

The Malayan Railways, which is limited to the national boundaries of the Federation of Malaya and Singapore, has an agreement with the Royal State Railways that permits it to use Thai lines south of Haad Yai. This enables trains to run northward from Prai to Padang Besar and Haad Yai and then southward to Sungai Kolok and Tumpat, thus making it possible for freight and people to circulate over the only large rail loop in the net. Tumpat in northern Kelantan is nearer in rail miles to Penang via Haad Yai than it is to Singapore. Between 1920-31 and 1945-54, this line to Haad Yai was the only rail connection Kelantan had with the outside world.

At the present time nearly all traffic in northwest Malaya is routed south through Gemas and then north to Tumpat. This is being done although the distance between Prai and Tumpat via Haad Yai is 294 miles while that via Gemas is 680 miles (Fig. 3). If senders request that their freight move northward through Haad Yai over the shorter distance to save time and extra freight

[10] The distance from Krung Thep to Thai terminal railway cities on the main lines is as follows: to Padang Besar, 604 miles; Sungai Kolok, 728 miles; Aranyaprathet, 159 miles; Nong Khai, 361 miles; Ubon, 359 miles; Chiang Mai, 453 miles; and Kanchanaburi, 121 miles.

charges, the Malayan Railways grant it "to avoid undue liability for claims on account of 'deviation.' "[11]

Otherwise, the Malayan Railways management sends freight over the longer route because its system needs the business. It has extra car and locomotive capacity which it can use. In contrast, there is a shortage of cars and locomotives in Thailand and apparently more freight than the Thai railways can carry. Consequently, there is a shortage of Thai cars for international service. Since the Malayan Railways established a policy of routing freight south to Gemas, through traffic between northwest and northeast Malaya via Haad Yai has dwindled. Yet, about 25 per cent of the traffic going into Thailand from northwest Malaya is destined for northeast Malaya.[12]

The quantity of international rail traffic between Thailand and Malaya is not large, most of it coming from Thailand, particularly from Changwat Songkhla and other changwats located near the border. One should remember that Haad Yai is 577 miles from Krung Thep but only 133 miles from Prai. If supplies of rice, fresh fish, and other food products were shipped to the Krung Thep metropolitan area from the extreme southern part of peninsular Thailand, they would encounter competition from local products. Moreover, Thailand exports food products whereas Malaya has had to import food such as rice and fish. Most of the Thai commerce flows to the East Coast Line in Malaya.

Thailand-Laotian cooperation. International rail commerce is greater between Thailand and Laos than between Thailand and Cambodia or Thailand and Malaya. Prior to 1955, Udon Thani was the northern terminus for the railroad line which bifurcated at Nakhon Ratchasima (Fig. 1). Then in September, 1955, the line was extended about 35 miles to Nong Khai and this city on the Mekong River became the terminus (Fig. 4).

Prior to 1955, about 80 per cent of the Laotian imports passed through Saigon and Cambodia, and about 20 per cent from or through Thailand. "In 1955, of the total imports of Laos about 47 per cent came from and through Thailand, 51 per cent through Cambodia and South Viet-Nam, and 2 per cent from Hong Kong by air. Of its total exports about 47 per cent went to, or through, Cambodia and South Viet-Nam and about 53 per cent through Thailand."[13]

Thailand-Cambodian cooperation. In spite of public announcements, overtures between the two countries, and several conferences, the growth in the flow of rail commerce between Thailand and Cambodia has been disappointing and often completely interrupted. Thailand and Cambodia have not signed an agreement providing for the freedom of in-transit goods. Whenever the two countries are not having disputes, Thai trains can pass through Aranyaprathet to Poipet, Cambodia. But the flow of goods between the two capitals or intermediate points in Thailand and Cambodia is handicapped and severely crippled by the need to transfer freight from cars of one nation to those of the other.

Cambodia's only railroad line is single track. On this line a combined passenger-freight train moves each way daily between Phnom Penh and Poipet. Autorails, combined passenger cars and French diesel engines, travel in both directions biweekly.

Flow of Passengers and Goods

Passenger service. In southeast Asia where relatively few people own cars or

[11] Information included in a letter from H. M. Sweeney, Traffic Managers Office, Malayan Railway, dated April 30, 1959.

[12] *Ibid.*

[13] United Nations, *op. cit.*, p. 186.

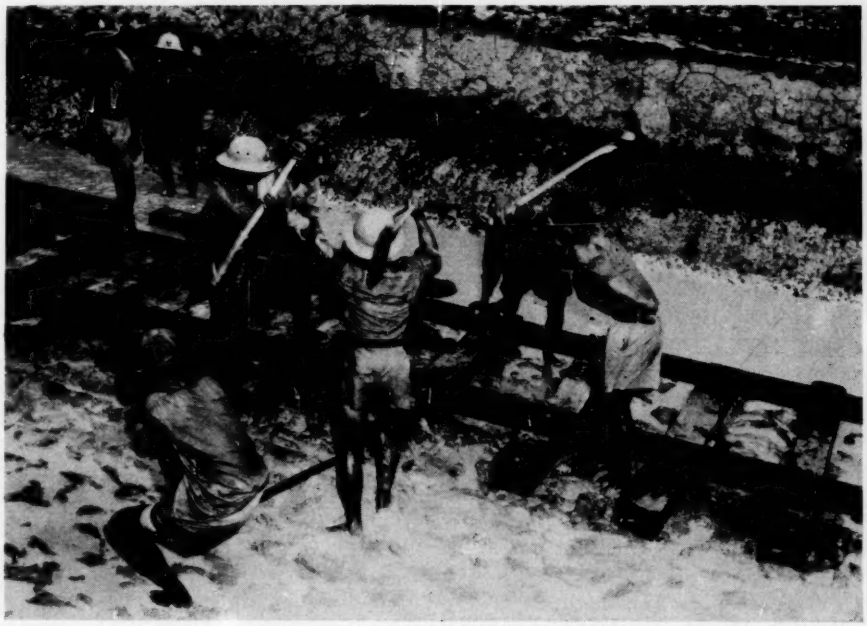

FIG. 4 .If railway construction between Udon Thani and Nong Khai were to continue in the rainy season men must work in the mud.

travel by plane and where poor roads impede the development of bus routes, people travel by train. Between 1952-1956 inclusive, the number of passenger-kilometers traveled rose steadily in Cambodia, but in Thailand it reached a peak in 1954 and then declined the next two years.[14] Statistics were not published for Malaya. The monthly averages of passenger-kilometers for Cambodia and Thailand are shown in Table 1.

In 1957, the number of passenger-kilometers in Thailand was more than in 1956, but not as high as that of 1954. The drop in passenger-kilometers was partly due to an increase in fares but also to a shortage of coaches. Additional cars were available in 1957, but by then, due to an increase in mileage of all-weather roads and the use of buses, the railway was not able to recapture all of its lost trade.

[14] *Ibid.*, p. 223.

The international passenger rail load is light. The heaviest flow is between Thailand and Malaya on the International Express. Large ocean liners cannot enter the Chao Phraya River to reach Krung Thep, but many do dock at Singapore. Passengers disembarking at Singapore may fly to Krung Thep. Holiday traffic between peninsular Thailand and northern Malaya has increased during the last decade. Only a few people travel by train between the capitals of Thailand and Cambodia because the border is often closed; first class passenger accommodations on the Thailand Eastern Line are not too good; and because people who wish to visit Angkor Wat or the Thailand and Cambodian capitals can travel faster and with greater comfort by plane.

Comparatively few Thais and Malayans travel in first class cars; there are only a few air-conditioned ones. The second class cars are usually crowded, and

TABLE 1

PASSENGER-KILOMETERS IN MILLIONS (MONTHLY AVERAGES)

Country	1948	1952	1953	1954	1955	1956
Cambodia	–	3	4	4	5	6
Thailand	109	188	191	196	167	155

the third class ones are packed with people and goods. The weight of the goods carried by a passenger is often more than his own weight. The bulky goods often take up much of the space, and the aisles are usually crowded with people and goods. At the stations the ubiquitous view is one of people unloading or loading large bundles and baskets through the coach windows. The quantity of goods is almost unbelievable. This custom, plus the vendors hawking their wares and the practice of people meeting and seeing their friends off, makes the railway station a crowded picturesque place.

Within Malaya, the largest passenger flow is on the West Coast Line between Singapore and Kuala Lumpur and the second largest is between Kuala Lumpur and Prai.

Within Thailand, the largest passenger flow is on the Northern Line between Krung Thep and Chiang Mai. The second largest passenger flow is on the North Eastern Line serving Nakhon Ratchasima and terminating at Nong Khai or Ubon. The Southern Line linking Krung Thep to Haad Yai, Padang Besar, and Sungai Kolok ranks third in passenger flow, and the Eastern Line connecting Krung Thep to Aranyaprathet ranks fourth.[15]

Freight. In 1956, freight ton-kilometers was greater in all three countries than it was in 1955. The monthly averages of ton-kilometers for the countries of Cambodia, Malaya, and Thailand are shown in Table 2.

During this five-year period, 1952-1956, the freight ton-kilometers in Thailand increased 87 per cent and 19 per cent in Malaya. Although the Cambodian single railway line had a steady increase in the number of passengers hauled during this same five-year period, the amount of freight carried was very erratic oscillating between five million ton-kilometers in 1954 and two million in 1955.

Today in Thailand, the North Eastern Line serving Northeast Thailand and Laos carries the greatest ton-kilometers of freight and the Northern, Southern, and Eastern lines rank in second, third, and fourth places, respectively.[17]

In Malaya, short sections of the West Coast Line and its spurs carry the heaviest freight loads. These short lines funnel most of Malaya's exports to the sea. Singapore, Prai, and Port Swettenham have become the three principal railheads. The short lines to Port Weld, Teluk Anson, and Port Dickson still carry freight but their importance has declined. During the Second World War the Japanese ripped up the short branch line to Malakka and it has not been replaced.

[15] Ahna Ramyananda, *op. cit.*, letter of January 30, 1959.
[16] United Nations, *op. cit.*, p. 223.
[17] *Ibid.*

TABLE 2

FREIGHT TON-KILOMETERS IN MILLIONS (MONTHLY AVERAGES)[16]

Country	1948	1952	1953	1954	1955	1956
Cambodia	–	4	4	5	2	6
Malaya	26	31	31	32	33	37
Thailand	25	46	54	57	65	76

FIG. 5. New diesel engine pulling a passenger train between Nakhon Ratchasima and Nong Khai.

Source of Materials

Nearly all of the rolling stock and rails are imported. At workshops near Kuala Lumpur, coaches are finished with local woods but the metal frames are imported.[18] Malaya buys its equipment from the United Kingdom and Cambodia buys from France. Thailand gets its equipment primarily from Japan and Belgium and some from the United Kingdom and the United States.[19]

Ballast and railway sleepers (ties) are supplied locally. In Thailand, sleepers made of teng, rang, takian, maka and lumpor on the average last about ten years. The Royal State Railways operates a wood impregnating plant at Huey Mud on the Southern Line for the treatment of its sleepers.[20] In Malaya, sleepers made of indigenous hardwoods such as merbau and chengal last from 10 to 14 years.

With increasing use of diesel engines, all three countries are becoming more dependent on imported fuels (Fig. 5). Formerly, Malaya relied entirely upon its lignite mines at Baty Arang in Selangor, and Thailand, upon fuelwood from its extensive forests. Both countries still use some lignite and wood burning locomotives. To date, the lignite at Mae Moh, Changwat Lampang in northern Thailand, has not proven satisfactory for locomotive use because of the high sulfur content. Thailand imported lignite from Malaya for its steam power plants but not for use in locomotives as is sometimes reported. The Thais experimentally burned rice-husk briquettes during the 1930's, but these were not successful.

Future

Krung Thep is not only strategically located at the center of the railway net

[18] Fisher, *op. cit.*, p. 123.
[19] Ahna Ramyananda, *op. cit.*, January 30, 1959.
[20] *Ibid.*

in Thailand, but it also occupies a similar position in regard to this international net. Its focal position would be enhanced if there were a free flow of people and goods between the four countries. International railway commerce may always be limited by the fact that these countries produce many similar products for export and that a large part of the population in Malaya and Thailand is located near and oriented to the sea. But the fact that "intransit agreements" have not been signed between Thailand and Malaya and Thailand and Cambodia helps substantiate the feeling that nationalism and other cultural barriers are handicapping the flow of trade. Nationalism also plays a part in routing freight from Prai to Tumpat via Gemas rather than via Haad Yai.

Intransit commerce between Thailand and Laos appears to be well established. Facilities are being improved, and the opportunities for steady growth appears bright.

How much rail commerce might move between Phnom Penh and Krung Thep or intermediate points if an intransit agreement were signed is not known, but Cambodia's new Port of Sihanoukville if completed in 1959 will form a new outlet to the sea and detract from the former potential advantage of a seaport in Krung Thep.[21] Phnom Penh is about 200 river and canal miles from Saigon, and 400 rail miles from Krung Thep but only about 141 road miles from the Port of Sihanoukville.

Perhaps during the next decade emphasis will be placed on rehabilitating and improving the facilities of the present railway net rather than on expansion of its mileage. Reactivation of the systems following the Second World War has been an enormous problem. In general, railway stations and storage facilities are being improved; new bridges constructed, and old ones repaired; double track and additional sidings are being laid; and better rolling stock purchased. With new and heavier diesel locomotives and the anticipated heavier non-agricultural loads the Thais are now replacing 50 with 70 pound per yard weight rails and new switches. Automatic couplers and telecommunications will help improve the speed and efficiency of traffic flow.

Although rail construction reached a peak in 1910-1920 and has declined since that time, additional mileage may be added during the 1960's.

The greatest expansion of railway mileage may be in Thailand if the Thai State Railways can get money to build lines for political and military as well as commercial purposes. Blueprints for expanding the rail net in Northeast, Northern, and Southeast Thailand have been ready for over a decade. The Thais from experience are painfully aware of the importance of interior communication lines which can be operated throughout the year. They have not forgotten how foreign countries used their large navies to take territory which the Thais considered theirs. To weld the various parts of the country to its capital has always influenced railway construction and some Thais still believe in such a policy. Undoubtedly the construction of new or improved highways may better meet the need in many places for the extension of transport facilities for both commercial and political purposes. At the present time, the proposed rail construction of 1946 appears to some outsiders to be overly ambitious and economically unjustified. However this expansion is potentially possible and some of it may take place before the end of the century.

Perhaps the most important future commercial extension of the net in Thai-

[21] Seventh Annual Report of the Consultative Committee of the Colombo Plan (1958), *op. cit.*, p. 33.

land is that of the so-called "Korat"[22] cut-off line which would remove the severe bottleneck in the Northeastern Line now serving both (1) the largest geographic region in Thailand and (2) Laos. This proposed cut-off from Genoki to Bua Yai would shorten the distance between Krung Thep and Nakhon Ratchasima by 162 miles.[23] Moreover the cut-off would be built with more gentle curves and grades, thus making it possible to move trains at greater speeds with less cost. When completed it would provide an alternate route for trains mounting or descending the high escarpment which separates Northeast Thailand from the Central Plain. It should be recalled that the Northeastern Line carries more ton-kilometers of freight than any other in the country. Work on this cut-off was started some years ago but in recent years construction has been intermittent.

There is doubt about the need of a branch line southwestward from the Southern Line near Surat Thani to Phangnga and Tha Nun, the latter located across the channel from the island of Phuket. The total length of this line would be 131 miles. Construction was started in 1941. The Second World War interrupted the work, and it was not resumed until 1951. A part of the line was completed and opened to traffic on April 13, 1956. This short spur from Tung-Poh Station to Thakanon Station is only 19 miles long.[24]

At present, trade in the Phuket area and along the west coast of peninsular Thailand is oriented south to Penang and Singapore or northward to Burma. This area's most valuable export is tin but there is a question as to whether Thailand produces enough tin to make construction of a smelter worthwhile. Unfortunately from an industrial standpoint, Thailand's limited tin production is divided between the east and west coasts of the peninsula with no rail connection between the two areas.

Plans for a connecting link between the railways of Thailand and Burma existed before the Japanese built the Railway of Death. In the past the Thais considered various routes.[25] One of these alternate routes extended from Sawanhakok across the Tenasserim Range to Mae Sodt, Burma. The poorly-constructed line built by the Japanese between the two countries never had an opportunity to prove if it could be economically successful during peacetime. The Railway of Death was constructed for political and military reasons. If another line were constructed between the two countries in the future, the political factor might again play an important if not dominant role.

In November, 1956, the Cabinet Council of Thailand decided that a branch line should be built from the Northern Line westward through Suphan Buri to Tak and Mae Sodt, Burma.[26] Before these plans were put into operation, General Sarit took over the government.

Malaya plans to construct a new line from Port Swettenham through Kuala Lumpur and Raub to Kuantan on the east coast (Fig. 3). This work was started in 1957 with the reconstruction of the road between Port Swettenham and Kuala Lumpur. With nine freight-passenger trains running daily in each direction, the heaviest freight flow is concentrated here.[27] Whether the line will ever be built across the Main Range to Kuantan remains in doubt. To date the nature of the terrain and the conse-

[22] Korat is a foreign name given to the city of Nakhon Ratchasima.

[23] International Bank for Reconstruction and Development, *A Public Development Program for Thailand* (non-printed copy), March, 1959, p. 134.

[24] Ramyananda Ahna, *op. cit.*, June 17, 1958.

[25] Thailand, Ministry of Communications, *op. cit.*, p. 16.

[26] The Bangkok *Post*, November 26, 1956, p. 7.

[27] R. W. Steel and C. A. Fisher, *Geographical Essays on British Tropical Lands* (London: George Philip & Sons, Limited, 1956), p. 321.

quently high construction costs are two of the important factors which hinder railroad construction between the capital and the east coast cities.[28] This young country will need to decide whether the political importance of connecting various parts of its territory with the capital is worth the cost. From an economic standpoint, development does not seem justified.

[28] *Ibid*, p. 318.

In conclusion it seems that with some minor modifications the present open railway net will retain its present shape and extent for the next few years. Moreover water may well remain the dominant type of national and international transportation for Thailand, Malaya, and Cambodia for the rest of the Twentieth Century. All-weather highways will continue to grow and carry larger and larger relative amounts of goods in these countries.

GEOGRAPHIC ASPECTS OF INDUSTRIAL GROWTH IN THE MONTERREY REGION OF MEXICO*

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SINCE the year 1939, Mexico's manufacturing industries have experienced an unusually rapid expansion, and by 1955, according to the Ministry of Economy, the industrial production volume was approximately doubled. Today the second most important industrial state ranking behind the State of Mexico is Nuevo León, of which Monterrey is the capital. Next, in order of importance are the States of Jalisco, Puebla, Veracruz, Coahuila, Hidalgo, Guanajuato, and Yucatán.

Many geographers are interested in how the economy of Mexico is changing from an agrarian to an industrial base. This paper is an attempt to indicate some of the principle causes of industrial expansion in the Monterrey region. An effort will also be made to point out some aspects of the impact of manufacturing growth upon the internal structure of Monterrey.

Two of the primary factors responsible for industrial growth in Monterrey are location and investment climate.

Location

Market access. Monterrey has a favorable nodal position as a transhipment and processing center due to its proximity to the United States. Industry here had its origins during the Civil War in the United States. When the Union Navy blockaded the Gulf ports of the South, the Confederate states were forced to export their cotton to England via Monterrey and Tampico. Southern cotton was also exchanged in Mexico for much needed war supplies. Such an exchange gave rise to the establishment of small textile mills in Monterrey. At the close of the war, many of the commercial contracts made earlier were renewed, and the city continued to increase its economic ties with the United States. Fur-

* Much original and secondary data for this study were obtained from the Office of the Economic Secretary (Secretaria de Economía), the Bank of Mexico in Mexico City, and the Instituto Technológico and Monterrey Planning Commission in Monterrey. Without the assistance rendered by the personnel of these agencies, it would not have been possible to undertake such a project.

ther, the success of the first textile mills led local capitalists to form other textile plants; thus the current industrial agglomeration began.

The fact that the city lies a mere 150 miles south of the Mexican-United States border not only permitted cotton to move southward, but along with the cotton came the intangible asset, technological "know-how." The influence of United States techniques on Monterrey's industrial development is especially apparent today in connection with the production of steel; many foundry technicians and plant managers are trained in the United States.

A continued expansion of trade with its United States neighbor plus a greater extension of business with central Mexico brought about the need for improved market access. This, in turn, led to the establishment of a network of transfer facilities with Monterrey as the focus. A railroad line was completed to Tampico in 1891, and in 1905 a line was built to Matamoros, which is situated at the northeast extremity of the United States-Mexican border. Three other lines were added in rapid succession: (1) a line northward to Laredo, (2) a railroad connecting Monterrey with Mexico City via Saltillo, and (3) a road to Torreón and Durango.

In recent years a modern network of roads has been added. The Pan-American Highway proceeds southeastward from Monterrey to Tampico. To the east extends the Reynosa highway, completed in 1941 and another paved road to Mier. To the west is the paved highway leading to Saltillo and Torreón and extending to the El Paso-Mexico City highway at Durango.

Since 1955, Monterrey has become one of the chief air crossroads of Mexico. In addition to the international operations of American Airlines, the airport handles flights of Cía Mexicana de Aviacíon, S.A., which is associated with Pan-American World Airways.

Access to Minerals. The existence and growth of heavy and light industries implies an access to minerals for sources of power and raw materials. Estimates of Mexico's coal reserves range from 2.1 to 3.2 billion tons, of which 1.2 to 1.8 billion tons are considered to be of coking grade. The Sabinas Basin, northwest of Monterrey and long the chief production center, is known to have reserves in excess of one billion tons, all of coking grade. Sabinas coal is practically the only coal in Latin America that can be coked without blending; however, it does contain substantial quantities of ash.

Monterrey is situated at the foothills of the Eastern Sierra Madres which rise to the west and south and occupy about one-half of the total land area of the state of Nuveo León. While this range has been a minor obstacle to the creation of a rail and road network, it has served Monterrey as a valuable asset in the form of a watershed and as a source of water for power. Concerning electric power, the major producer and distributor in the Nuevo León region is the privately-owned Monterrey Railway, Light, and Power Company owned by private interests in Canada. This company supplies the city and surrounding area with both gas and electricity. In 1953, its installed capacity was 57,800 kilowatts, including about 25,000 kilowatts furnished by a government-owned steam plant. In addition to these facilities, the Falcón Dam on the Río Grande supplies access to an additional power increment of 31,500 kilowatts.

To the north and southeast of the city, in the State of Tamaulipas, lie the oil refineries of Reynosa, Arbol Grande, and Ciudad Madero with distillation capacities per working day of about 7,000, 23,000, and 88,000 barrels respectively. According to government statistics, these

plants were responsible for approximately 43 per cent of the total production of Mexican refineries in 1954.

Northwest of Monterrey are the Hercules iron mines in the State of Coahuila and the silver and lead mines of San Francisco del Oro in the State of Chihuahua. To the southwest are an estimated 60 million tons of iron ore at Cerro de Mercado and Durango in the State of Durango and the extensive silver-lead deposits of Conceptión del Oro in Zacatecas. The existence of the Durango deposits was the motivating force behind the establishment of the Monterrey-Durango rail link. Finally, the State of Nuevo León also contains appreciable deposits of fluorspar, sulphur and antimony.

The four preceding paragraphs, when summarized, indicate simply that within 150 miles of Monterrey are liberal supplies of coal, water, refined oil, silver, and lead, and within 250 miles are abundant quantities of iron ore.

Investment Climate

Historical Background. A rather rapid increase in the value of foreign investments in Mexico has occurred since 1940. All such investments amounted to 2.3 billion pesos in 1939, 3.6 billion pesos in 1948, and 6.3 billion pesos in 1952. Total capital invested in Monterrey industries also indicates the same general trend. From 100 million pesos in 1937, total investment increased to 500 million pesos in 1946 and reached 1.5 billion pesos in 1951.[1]

After the expropriation of oil in 1938, Mexican credit abroad was at a low level. However, the outbreak of the European war stimulated the demand for the Mexican products. Then in 1943, the reorganization of the Mexican public debt, which had been in default since 1914, and the beginning of service of this debt further restored confidence abroad. Thus, a favorable investment climate was created which still exists.

Availability of labor. Between 1940 and 1951, the population of Monterrey rose from 190,074 to 350,000, and in 1951 forty-six per cent of the economic population of the city were industrial workers.[2]

Skilled labor is scarce, but a large pool of potential industrial workers is available. Wage rates are moderate by United States standards, and it appears that the working population is amenable to training for most skilled occupations.

Government incentives. Under present legislation[3] the Mexican Government may grant tax exemptions to the following: (1) industries "providing services for economically important activities"; (2) industries devoted to the manufacture or production of goods not produced in the country; (3) industries devoted to the manufacture of goods not produced in the country in sufficient quantity to meet the needs of domestic consumers; (4) assembly operations, providing Mexican-produced parts represent at least 60 per cent of the product's direct cost; and (5) industries exporting their own finished or semifinished manufacturers, providing at least 60 per cent of the direct production cost of such products represents Mexican manufacture. Industries within such classifications are eligible for 5, 7, or 10-year exemptions or reductions from import duties and the surchanges thereon; the gross receipts tax, stamp taxes, and the normal income tax on industrial profits. The law limits tax reductions to a maximum of 40 per cent of the tax.

Since World War II, Mexico's commercial policy has been aimed at pro-

[1] Banco de México, S.A.

[2] Secretaria de Economía, Direccíon General de Estadística.

[3] See Law for the Development of New and Necessary Industries, published in the *Diario Oficial*, January 4, 1955.

tecting new and established manufacturing industries against foreign competition. High import duties, import licensing, and direct prohibitions have been enforced by the Government in order to encourage industrialization.[4]

Among the incentives to new foreign investment is the condition of free exchange convertibility. Mexico is one of the few members of the International Monetary Fund which has assumed the obligation freely to permit payments and transfers for current transactions.[5]

In 1900, General Bernardo Reyes, Governor of Nuevo León, influenced the passage of state laws which provided a 75 per cent exemption on local taxes for five to twenty year periods in favor of new industries. The term "new industries" is applied to the following: (1) establishments which manufacture products not previously produced in the state, (2) plants which introduce improved manufacturing methods, (3) enterprises which employ ten times as many workers as the largest plant manufacturing any one product, (4) communication or transportation corporations using means not previously connected, or (5) firms which promote tourist trade thru means not previously utilized.

Level of profits. As stated earlier, industrial wages and taxes are generally moderate. Mexico has been a country with relatively scarce investment funds and a high unit profit. Available capital can secure yields of up to eight per cent on obligations guaranteed by various government agencies. Higher yields are reported on stocks and bonds of many commercial, industrial, and mining firms. In 1950, all United States direct investments in Mexico, amounting to 414.5 million dollars, had earnings during that year of 43 million dollars, or somewhat more than ten per cent.

In an evolving economy such as that found in Mexico, the risks such as devaluation which face new investments are frequently greater than in a more established economy. Therefore, to compensate for such risks, the potential United States investor naturally looks for a rate of return proportional with the hazards.

In summary, the investment climate has been an important element in recent capital movements into the country, with United States capital accounting for a major portion of the increase. Despite some restrictions on fields of investment available to foreign capital, many American firms, attracted by the existence of abundant raw materials, a desirable market growth potential and a reasonably sufficient investment climate, are displaying an increasing interest in establishing subsidiaries within Monterrey.

Industrial Development

Monterrey today is popularly termed "The Pittsburgh of Mexico," and as a result of a high degree of concentration of manufacturing industries, Nuevo León has become Mexico's second most important industrial state, surpassed only by the Federal District. In 1952, there were in Monterrey alone 760 industries manufacturing over 500 products which ranged in variety from beer to furniture and from cheese to steel.

Mexico was the first Latin American country to establish a modern integrated iron and steel plant. The Monterrey Iron and Steel Work (Compañía Fundidora de Fierro y Acero de Monterrey, S.A.) was established in 1903 and until 1945 was the only pig iron producer in the country. In 1951, Mexico's total output of pig iron was 254,000 metric tons, of which 148,762 were produced by Fundidora and the remainder by Altos Hormos, S.A., at Monclova in the State

[4] *Investment in Mexico*, U. S. Dept. of Commerce, June, 1955, p. 20.
[5] *Ibid.*

of Coahuila. In recent years Hajalata y Lámina, S.A., of Monterrey has undertaken the production of sponge iron, which is mixed with scrap for the production of steel. In 1952, the output of sponge iron was 500 tons per month.

There are five principal silver-lead smelters in Mexico with a total yearly capacity of about 1,466,000 tons. Approximately one-half of this production is accounted for by the American Smelting and Refining Company of Monterrey, the American Metal Company of Torreón in Coahuila, and the Mazapil Copper Company of Conceptión del Oro in Zacatecas. All are strategically situated with respect to ore mines and coke supplies.

Several strong industrial groups are found in Monterrey. The "Fundidora" group controls the leading iron and steel mill (Cía Fundidora de Fierroy Acero de Monterrey, S.A.), iron mines near the city of Durango (Cerro de Mercado, S.A.), and coal mines at Cloete in Coahuila (Carbon y Coke, S.A.). The Carza-Soda family manages one of the largest breweries in the world, the Cervecería Cuauhtémoc, and a number of related enterprises, manufacturing cartons, crowns, and tinplate. The Policarpo Elizondo family controls a cottonseed oil mill (Algondera y Aceitera Monterrey, S.A.), a plant manufacturing lubricants and spare parts for industrial equipment (Monterrey Proveedor, S.A.), and a paint plant (Pinturas Monterrey, S.A.). The local cotton textile mills are formed into two basic gropus: the "Aurelio González" group, which includes the Cía Textile Reyneca and Textiles Monterrey; and the "Liaguno" group, which contains the Hilados del Norte spinning mill, the Textiles del Norte spinning and weaving mill, and the Industrias Textiles spinning mill.

Affiliates of United States companies include the National Carbon Company (dry batteries), Anderson, Clayton and Company (food processing), General Electric Company (electric lamps) and the Bakelite Company (polystyrene). Local cigarette plants are associated with United States and British tobacco interests.

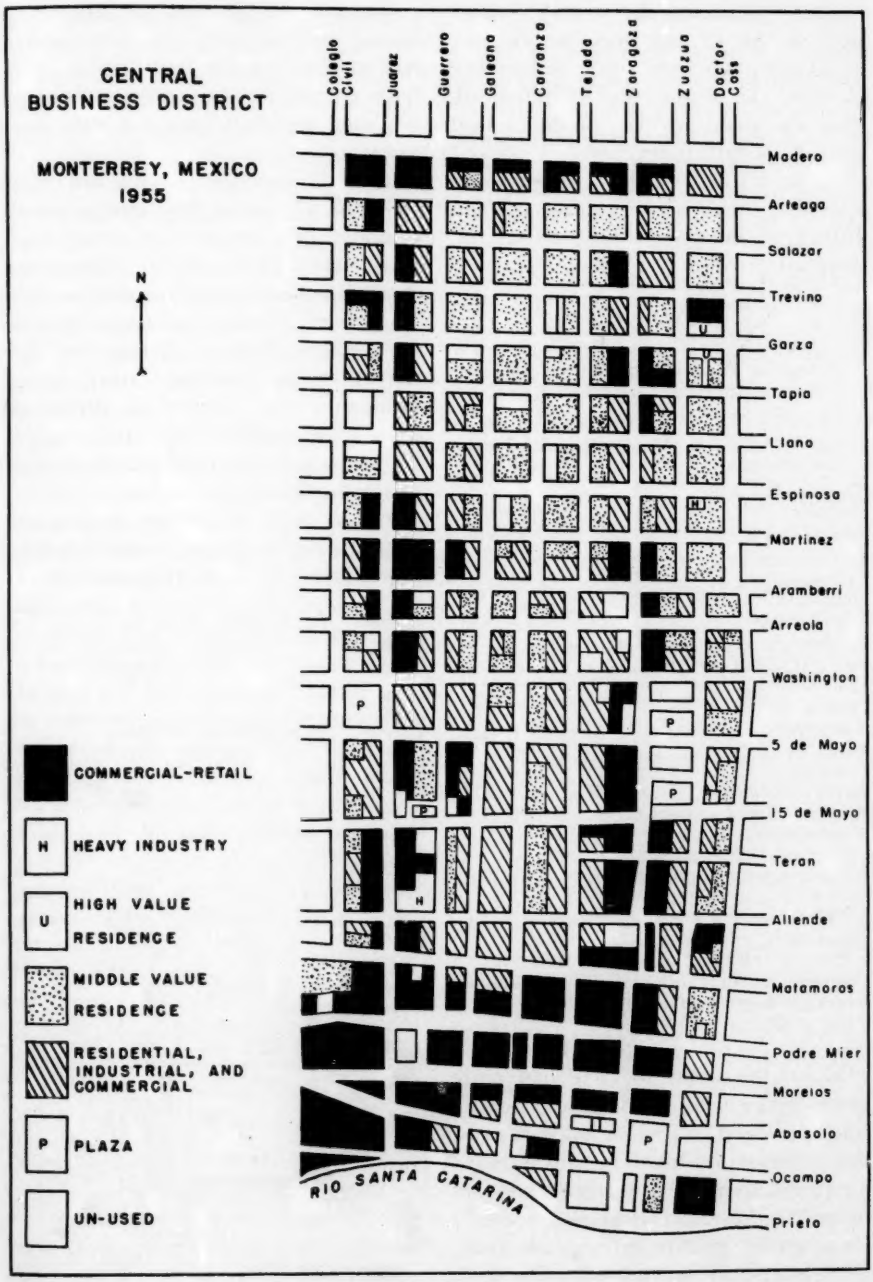
Some important manufacturing operations in Monterrey include the production of automobile parts, cement, chemicals, electric lamps, electronic equipment, furniture, glassware, leather, paint, pharmaceuticals, and plastic products. From January to August, 1957, sixty-four new factories were established, and the most important, in terms of capital investment, were the following: a glass fibers plant, a caustic soda and chlorine manufacturing plant, a railroad equipment plant, a steel products factory, and a tractor assembly plant.

Monterrey is also the headquarters for ten investment banks, eight commercial banks, four mortgage banks, two capitalization societies, one savings bank and has several branches of the Bank of Mexico. Deposits and clearings of Monterrey's banks are second only to those of Mexico City.

It can be readily seen that Monterrey contains a considerable number and diversity of industrial firms and is continuing this development. In 1937, there were within the city environs 438 industries, and after a period of two decades, the number had almost doubled. Here, then, is a very real and dynamic growth pattern that exists in close proximity to a great industrial nation, the United States.

Impact of Industrial Growth

Consider now the industrial impact on the city of Monterrey, as of 1955.


CENTRAL
BUSINESS DISTRICT
MONTERREY, MEXICO
1955
N
Colegio Civil
Juarez
Guerrero
Galeana
Carranza
Tejada
Zaragoza
Zuazua
Doctor Coss
Madero
Arteaga
Salazar
Trevino
Garza
Tapia
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RIO SANTA CATARINA
COMMERCIAL-RETAIL
H HEAVY INDUSTRY
U HIGH VALUE RESIDENCE
MIDDLE VALUE RESIDENCE
RESIDENTIAL, INDUSTRIAL, AND COMMERCIAL
P PLAZA
UN-USED

FIG. 1

Figure 1 illustrates the writer's conception of the Central Business District, based on a land-use study undertaken in 1955. The delimitation technique utilized was essentially that of the Central Business Height Index.[6]

Table 1 indicates the percentages of total floor space of the central business district of Sacramento and Monterrey, classified according to various uses.

TABLE I

PERCENTAGES OF TOTAL FLOOR SPACE OF CENTRAL BUSINESS DISTRICTS, SACRAMENTO AND MONTERREY, BY USES

Use Categories	Percentages (Monterrey, 1955)*	Percentages (Sacramento, 1953)**
Transient Residence	23	18
Clothing	16	4
Service Trades	15	4
Food	13	7
General Office	12	6
Household	10	5
Miscellaneous	6	6
Vacancy	5	5
Public and Organizational		14
Residential		7
Parking		6
Automotive		4
Variety		4
Financial		3
Headquarters Office		3
Wholesale and Industrial		3
Transportation		1
TOTAL PERCENTAGE	100	100

* Based on field studies conducted in Monterrey in 1955.

** R. E. Murphy and J. E. Vance, Jr., "A Comparative Study of Nine Central Business Districts," *Economic Geography*, Vol. 30, No. 4, (1954) p. 333.

Monterrey seems to have had more space devoted to clothing and service trade uses, and in general, appears to be more "central business" in nature due to a larger concentration of retail stores and offices. Sacramento had more floor space set apart for public and organizational, residential, and parking purposes. Both cities, interestingly enough, are quite similar in that they are both governmental and regional trade centers, and both central business districts contain flat sites, low buildings and expansion barriers.

[6] See R. E. Murphy, and J. E. Vance, Jr., "Delimiting the CBD," *Economic Geography*, Vol. 30, No. 3, 1954.

The rail network and the industrial locations within the city limits are concentrated just north of the central business district. No rail lines penetrate the delineated central business district. The large industrial area northeast of the central business district contains the American Smelting and Refining Company and Cementos Mexicanis plants. The industrial section due east of the business district is primarily occupied by the Fundidora plants.

Figure 2 illustrates the major residential pattern around the central business district of Monterrey as of 1955.[7]

[7] Value classifications correspond closely with those used by the Monterrey Planning Commission.

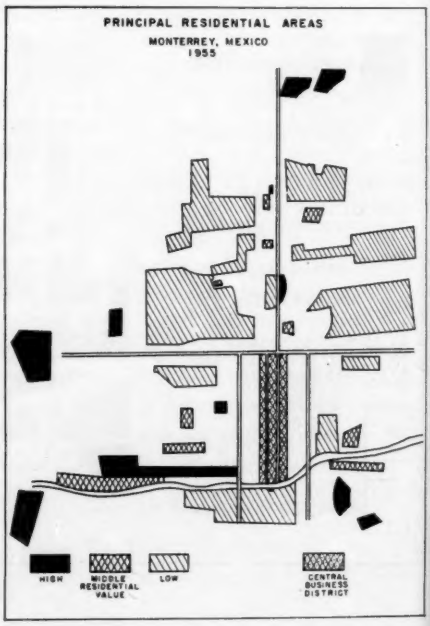

FIG. 2

Proceeding out from this district there is an inner ring of low-value dwellings (residencias humilides), followed by an outer ring or urban fringe of high-value residences (residencies lujosas). A large area of middle-value homes (residencias mediances) is found west of the district, along the Santa Catarina River. Northeast of the central business district there is a slight duplication in the areas covered by the residential and industrial classifications. This is due to the reservation by industry of some sections for housing units; thus, several localities might fall in both categories.

A few outstanding features of the central business district of Monterrey should be noted. Specific transport features—rail lines, road junctions, and the Santa Clara River—were partially responsible for the original site of the city. This development created the nucleus of the modern business district; however, the same transport facilities also acted as barriers to its expansion. This district has one important axis, resulting in a narrow or protracted district. The main business area is no longer within easy-walking distance, and some outer sections are becoming automobile-oriented. On the whole, Monterrey is built on a single plane, with only a few taller structures for hotels and offices.

Summary

The growth of the Monterrey region as an important Latin American iron and steel center is partly a reflection of a highly favorable access position with regard to raw materials and transfer facilities. At the same time, the importance of the market factor cannot be ignored. Monterrey is not only well situated with regard to the transshipment of goods to different regions of the United States of Mexico, but is strategically located with respect to the markets of the United States of America. Its relative access to markets and its proximity to a juxtaposition of coking coal and iron ore can be favorably compared with that of Gary, Indiana, or Pittsburgh, Pennsylvania.[8] The increase in secondary and tertiary activities also appears to be tied closely to the existence of both regional and national markets.

An added factor attributing to the regional industrial growth pattern is that of investment climate. Many American concerns, motivated by moderate wage costs and attractive rates of profit, are displaying an increasing interest in establishing subsidiaries in this region.

[8] Walter Isard and William M. Capron, "The Future Locational Pattern of Iron and Steel Production in the United States," *Journal of Political Economy*, LVII (1949), 118-133.

PLASTIC MAPS AND GLOBES

CATHERINE I. BAHN
The Library of Congress

THROUGHOUT the United States and in many foreign countries teachers are using the new lightweight plastic maps and globes as classroom teaching aids in any field which requires a visual understanding of the earth or a part of the earth. A few of these new items are described in this article.

Map of the Battlefield of Gettysburg is the first of a series of maps showing in three dimensions historic Civil War battlefields. Additional Civil War maps of Shenandoah Valley, Chattanooga, Virginia Peninsula, Vicksburg, Antietam and South Mountain are planned. About 20 × 14 inches in size and printed in six

colors on heavy plastic, the Gettysburg map is a reproduction of one prepared by General G. K. Warren, Chief Engineer of General Meade's Union Army of the Potomac. It is included in the official *War Department Atlas* published shortly after the Civil War. Positions of opposing forces are shown at the conclusion of the battle, as well as roads, fence lines, farms and buildings as they existed in July, 1863. The molding of the topographic features in three dimensions shows at a glance the critical importance of such locations as Cemetery Ridge, Round Top and Seminary Ridge. A description of the course of the battle is printed on the face of the map. This was produced by the Aero Service Corporation for the Haverford Map Company, Box 58, Haverford, Pennsylvania.

Shenandoah National Park, Virginia, Skyline Drive, an attractive three dimensional plastic relief map in four colors produced by the Aero Service Corporation, presents a bird's-eye view of the famous Skyline Drive and the surrounding area. It is 19 × 15 inches, on a scale of one inch to four miles, and was published from information provided by the United States Geological Survey and the Army Map Service. It may be purchased from Aeronautical Services, Inc., 229 Prince George St., Annapolis, Maryland.

A 12″ *Geophysical Relief Globe* manufactured by Geophysical Maps Inc., 101 Park Avenue, New York 17, New York is a small scale edition of a six foot relief globe developed for use on television networks, in universities and public institutions. It is pressure-molded in two hemispheres from sheets of plastic and may be obtained in either plain white or colors. An accompanying *Teachers' Guide* describes and suggests uses for the globes at different grade levels.

The Bro-Dart *Geophysical Relief Work Globe,* 12″ in diameter and molded of light, strong, vinyl plastic, has a simple one piece wire base into which the globe fits without fastening. The blue color is for maximum usefulness, for only land areas need be painted from an accompanying Jeppeson world map and the paint can be washed off by water. Latitude and longitude lines are embossed on water areas. An eight page *Teachers' Guide* is included with the globe which may be purchased from the Education Division of Bro-Dart Industries, 56 Earl Street, Newark 5, New Jersey.

Bro-Dart also has a *Raised Relief Map of the United States.* It is printed and pressure formed on a plastic coated material. The map may be rolled, unrolled and flattened out without injury to the relief and may be painted or colored with water or soap base paints or crayons and later washed off with water. This map of the United States, scale 106 miles to the inch, is printed on a 20 × 30 inch sheet with relief in white and water areas in "Wedgewood Blue." State boundaries, states, capitals and selected key cities, a graphic index and a complete legend are all printed in blue.

A topographical map of the visible side of the moon, titled *The Moon,* is printed in blue on white vinyl plastic. The craters, peaks, mountain ranges, valleys and plains of the Moon's surface are shown in raised relief. In the construction of the original pattern, each crater and land mark was carved to scale on the plaster casting through the use of dental tools. The model is 21 × 16 inches, with a horizontal scale of about 1:9,000,000, a vertical scale of 1:600,000, and a convex hemispherical projection. The map can be purchased from the publisher, Space Craft, Inc., P.O. Box 576, Harbor City, California.

Farquhar Transparent Globes, 3724 Irving Street, Philadelphia 4, Pennsylvania, has a star sphere with a terrestrial globe which is designed to give the

student the picture of the sky-earth relationship for any date at any time and from any geographic position. The position of the moon and planets can be shown with a marking pencil, and satellites can easily be traced on the star globe to show their path overhead. This transparent lucite globe-within-globe device is a 12″ diameter Celestial Globe with Sun Pointer and a 6″ diameter Colored Terrestrial Globe with a collar base.

Earth Curved Relief Maps of Europe, Asia, Africa, Australia, South America, and the *North Polar Projection* are made of a high-impact styrene plastic with land areas in tones of ochre and sepia and the water areas in a deep turquoise. They are 23 inches in diameter, 6 inches deep and may be obtained from Panoramic Studios, 6122 N. 21st Street, Philadelphia 38, Pennsylvania.

Aero Service Corporation, photogrammetric engineers who worked with the Air Force in relief mapping during World War II, now make many of the plastic relief maps for classroom use. The *Aero Geographical Terms Model,* 52 × 46 inches, is printed in five colors, depicts and names 116 geographical terms and includes 35 paper copies and a teacher's manual. A set of 12 United States Geological Survey quadrangles representing different types of physiography, 17 × 22 inches are available. Aero Plastic relief maps of the *United States, Canada, Europe, Venezuela, World, South America, New Jersey, California, Wisconsin, Pennsylvania* and *New York* average about three by four feet in size. Illustrations of the maps and more detailed information may be obtained by writing to Relief Model Division, Aero Service Corporation, 210 East Courtland Street, Philadelphia 20, Pennsylvania.

Plastic relief maps of parts of the United States, the Hawaiian Islands and Alaska on a scale of 1:250,000 and a 1:1,000,000 series (International Map of the World type) of various world areas may be purchased from The Commanding Officer, Army Map Service, 6500 Brooks Lane, Washington 25, D.C. A certified check or money order is required. Graphic indexes have been published for each map series depicting the geographical area covered by individual plastic maps with a general description of the map features.

Plastic inflatable globes have become increasingly popular. C. S. Hammond and Company Inc., 515 Valley Street, Maplewood, New Jersey has the 18 inch *International Globe;* Standard College Globes Inc., 9 W. 57th St., New York 19, N.Y. has the 18 inch *New Standard College Globe;* and Geographia Map Co., 145 West 57th Street, New York 19, New York has a similar one. Inflatable globes may sometimes be obtained at greatly reduced prices through advertising promotions such as those conducted in the past by Safeway Stores, Chicken of the Sea Tuna and Colgate-Palmolive Company.

These relatively inexpensive maps and globes of plastic are receiving increased use as teaching aids. The advantages of light weight, ease of storage and durability, as well as usability as a working tool, make them popular with teachers and students. Parent Teacher Associations and similar organizations are often willing to contribute to the cost of such items for school use.

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The 45th Annual Meeting of the National Council for Geographic Education will be held in Cincinnati, Ohio, on November 25-6, 1960. Will we see you there?

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The history of the JOURNAL OF GEOGRAPHY is an interesting one, for it is the outgrowth of two previous publications. The *Journal of School Geography*, a periodical especially devoted to the teaching of geography, was first published in January, 1897. Three years later the first issue of the *Bulletin of the American Bureau of Geography* came from the press. Both periodicals were successful, but since the aims and objectives of the two were similar they combined to form the JOURNAL OF GEOGRAPHY. The first issue of the JOURNAL OF GEOGRAPHY appeared in January, 1902, and the magazine has been published regularly during the school year since that time. The publication has had only seven editors, five of them serving prior to 1920. Professor George J. Miller edited the JOURNAL OF GEOGRAPHY from 1920 until 1950, guiding it through 30 critical years. Since 1950 Professor Thomas Frank Barton of Indiana University has served as editor.

The JOURNAL OF GEOGRAPHY is the official publication of the National Council for Geography Education. Both the organization and the publication work "to promote geographic education and research and to secure cooperation between the various fields of geography in the public schools and colleges." In addition to the JOURNAL OF GEOGRAPHY the Council also publishes professional papers, leaflets, booklets of the "Do It This Way" series, and special publications of various kinds. During the coming year it is the hope of the Executive Board to extend the list.

Each year annual meetings are held, usually during the fall, that bring together teachers of geography and the social studies—elementary, high school, and college—from all parts of the United States and Canada in a stimulating and pleasant fellowship. The programs provided at these meetings, together with the papers and articles published in the JOURNAL OF GEOGRAPHY, furnish an excellent cross-section of scholarship in the United States. The most recent meeting, held in Detroit, was exceedingly well attended. The 46th Annual Meeting will be held in Cincinnati on November 25-26, 1960.

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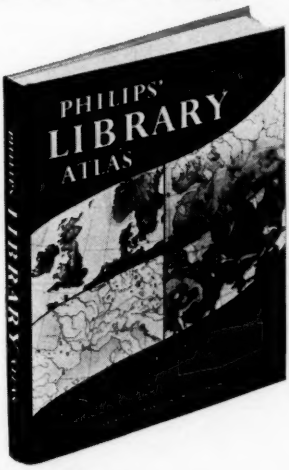

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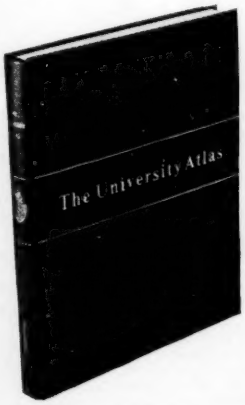

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